# IRE Transactions on AUDIO

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## IRE PROFESSIONAL GROUP ON AUDIO

The Professional Group on Audio is an organization, within the framework of the IRE, of members with principal professional interest in Audio Technology. All members of the IRE are eligible for membership in the Group and will receive all Group publications upon payment of an annual assessment of $2.00.




### IRE TRANSACTIONS[R] on AUDIO

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# Message From the New National Chairman

First I want to thank the membership of the Professional Group on Audio for the opportunity to serve you in this capacity. The six previous National Chairmen have established a record of progress which must be maintained, and surpassed if possible. Specific mention should be made of the successful term of our outgoing Chairman, Dr. W. E. Kock of Bell Telephone Laboratories. Also we have been fortunate to have for two successive (and active) terms as Vice-Chairman, Mr. Murlan S. Corrington of RCA. You will be pleased to know that Mr. B. B. Bauer has accepted reappointment as Secretary-Treasurer, and that Prof. A. B. Bereskin will continue as Editor-in-Chief for 1956–1957. These two appointive offices require a large amount of work and considerable judgment, and they are well filled. We have an able and experienced group of committee chairmen for 1956–1957, listed elsewhere in this issue. A full roster of committee membership will be published later. PGA is anxious to develop additional leadership, and your interest in committee activities is solicited.

The principal functions of the Professional Group on Audio have been the organization of audio sessions for national and regional IRE conventions and conferences, and the publication of IRE TRANSACTIONS ON AUDIO. Each year we have made some progress in both of these matters. This year it is our goal to expand our aid to PGA chapters, and to render assistance toward the formation of additional chapters in those sections having sufficient PGA membership to support chapter activities.

For several years PGA has organized more than one audio session at the Spring IRE Convention in New York. PGA usually sponsors an audio session in the fall at the National Electronics Conference, and one is in the planning stage for 1956. Some years it has been possible to organize an audio session for the WESCON Conference, and this is being done again this year. PGA has not conducted special symposia on its own, as some professional groups have done, but it might do so if membership interest so indicated.

IRE TRANSACTIONS ON AUDIO continues at approximately the same volume of publication. However the quality of technical papers has improved again within the last year. In addition to a number of specialized audio papers, there have been articles specially prepared on general audio subjects for PGA readers. It is our intent to expand this part of the publication program. The Publications Review committee is being reactivated, in order to prepare for IRE TRANSACTIONS ON AUDIO more reviews of audio articles which have appeared elsewhere. The PGA Awards system has stimulated further interest among audio authors, as it was intended to do. During 1956–1957 a Student Audio Papers Competition will be announced, as a step toward encouraging greater professional interest in audio among students.

The number of PGA chapters continues to grow, the latest being in Hawaii. A special newsletter from the PGA Chapters Committee to chapter chairmen will be inaugurated this year, circulating suggestions from chapters concerning program, promotion, and solutions to specific problems. Chapters, this will depend on your contributions.

PGA is joining with other participating organizations and agencies in supporting the second International Congress on Acoustics in Cambridge, Massachusetts, June 17–23. An outstanding and worthwhile program has been planned, including a number of invited papers by foreign authors in acoustics and audio. The Acoustical Society has been primarily responsible for planning and arrangements.

The membership of IRE-PGA is now over 3,300, making it the largest segment of the audio engineering population. The financial report shows a healthy reserve approximating closely the budget for 1956–1957, which goes entirely for services to the membership, principally the costs of publication.

The Professional Group on Audio is your audio organization within the framework of the IRE. It will become what you decide to make it through your suggestions and your assistance to PGA both nationally and in the chapters.

Daniel W. Martin, *Chairman*

# PGA News

## IRE-PGA ADMINISTRATIVE COMMITTEE MEETING HIGHLIGHTS

### Election Results

Daniel W. Martin was elected Chairman and Andrew Jacobson was elected Vice-Chairman for the year 1956–1957.

Semi J. Begun, Alexander B. Bereskin, and Harry F. Olson were elected to the Administrative Committee for the years 1956–1959.

### Committee Appointments

Benjamin B. Bauer was reappointed as Secretary-Treasurer of the IRE-PGA and Alexander B. Bereskin was reappointed as Editor-in-Chief of the IRE Transactions on Audio.

Marvin W. Camras was appointed as Chairman of the Chapters Committee, which has acquired new duties of improving and increasing the activities of the individual PGA Chapters.

Philip B. Williams has been reappointed Chairman of the Program Committee with Frank H. Slaymaker (East Coast), Semi J. Begun (Midwest), and James J. Noble (West Coast) as Regional Program Chairmen.

Harry F. Olson has been appointed as Chairman of the Awards Committee.

A complete listing of officers and committee chairmen will be published in an early issue.

### Treasurer's Report

Gentlemen:

The PGA is in excellent financial shape with the total income exceeding total expense during fiscal 1955 by about 5 per cent. Our balance in the treasury as reported by Headquarters is $8,163.87. Our balance in the Group treasury as of February 29, 1956 is $9,616.81.

There was a continued growth of membership.

| *February 1, 1956* | | *February 29, 1956* | |
|---|---|---|---|
| Paid Members | 2,742 | Paid Members | 2,859 |
| Paid Students | 374 | Paid Students | 407 |
| Unpaid Members | 46 | Unpaid Members | 56 |
| Total Active Membership | 3,162 | Total Active Membership | 3,322 |

The growth of Student Members is a highly desirable situation.

Our expenses per member in calendar 1954 were almost exactly $3.00, and during 1955 they were $3.15. The assessments and matched funds furnished $3.00 of this amount, the balance being supplied by Advertising and Sale of Publications. Advertising at the present time constitutes about 6 per cent of our income and Sale of Publications approximately 9 per cent of our income.

The balance on hand at the Headquarters is equivalent to 10 months operating expenses which, in my opinion, is a satisfactory balance. I do not recommend any change in the PGA financial policy at the present time.

Signed,
B. B. Bauer, *Secretary-Treasurer*
Finance Committee.

## PGA CHAPTER ACTIVITIES

### Boston, Mass.

A pair of related papers were presented before the Boston Chapter on March 29. The first of these papers on "An Electro-Dynamic Pickup Using the D'Arsonval Principle" was presented by John H. McConnell of Electro-Sonic Laboratories, Inc. The second paper on "A New Phonograph Turntable Design" was presented by Thomas D. Coe of the A. F. Cambridge Research Center. Both the turntable and the pickup were used in a demonstration following the presentation of the papers.

### Cincinnati, Ohio

The combined Cincinnati Section and Professional Group on Audio held a meeting on March 13. At this meeting Professor A. B. Bereskin discussed "A 3,000 Watt Audio Power Amplifier" which had been developed for use in direct air to ground communication systems.

### Cleveland, Ohio

On March 1 Paul W. Klipsch spoke before the Cleveland PGA Chapter on "Recent Developments and Applications of Corner Transducers." Thumb-nail sketch of Paul Klipsch: Owner, Klipsch and Associates, Hope, Ark., Acoustics Engineer. B.S. in E.E., and Deg. of Engineering in E.E.; presently manufacturing loud speaker, known as Klipschorn. Author of papers on geophysics and electronics; patents pending relating to geophysics, acoustics, firearms. Member AIEE, IRE, Acoustical Society, Tau Beta Phi, Sigma Xi. Formerly associated with General Electric, Anglo-Chilean Nitrate, Subterrex, Independent Exploration Co., and was an officer in the Ordnance Dept. A.U.S.

### Dayton, Ohio

The following 1955–56 officers have been announced for the Dayton IRE-PGA Chapter:

*Chairman*—Nathaniel Braverman
*Vice-Chairman*—John Mayer
*Secretary-Treasurer*—Theodore Rynda
*Program Chairman*—Charles Franklin
*Membership Chairman*—Edward Lazur

(All of the above are associated with the Wright Air Development Center, Dayton, Ohio.)

**Pearl Harbor, Hawaii**

We have just heard that an application, in good order, has been received from the Hawaii Section for the organization of a PGA Chapter in that area. The organizer is D. H. Da Shiell of USN, Bureau of Ships, Navy Yard, Pearl Harbor, Hawaii.

(There must be some way of arranging for an inspection trip to this group.)

**Philadelphia, Pa.**

At a joint meeting of the IRE-PGA and the local section of the Acoustical Society of America, in Philadelphia, Pa., Mr. Homer Dudley of Bell Labs. spoke on "The Physical Principles Involved in Speech Synthesis."

The meeting was held at the Franklin Institute, Lecture Hall and was preceded by a "Meet the Speaker" dinner at Holland's Restaurant.

**San Antonio, Texas**

January, 1954 showed a count of nine members in the Section. By the end of 1954 ten signatures had been obtained. The move was approved by the Executive Committee, and in February, 1955 the Chapter was approved by the National IRE Committee. Bill Case was elected Chairman.

In January, 1955 the Chapter sponsored a meeting with Howard Souther and A. W. Wiggins of Electro-Voice as guest speakers. More than 60 members and guests were present.

August, 1955 was an outstanding meeting, with 138 interested spectators present. Paul Klipsch from Klipsch and Associates was the speaker.

In October, 1955, B. B. Bauer presented a taped lecture and slides. 35 members were present.

The spring session was held March 1, 1956, with Dr. E. E. Mikeska as the principal speaker. His discussion was pertinent to the factors affecting the acoustical qualities of rooms, with illustrations of modern techniques and designs.

**San Francisco, California**

The following account is reprinted from the March, 1956 issue of the San Francisco Section—Grid.

TECHNOLOGY IN TAILS

Any audiophile who has yearned for the opportunity to run an A/B between a real live symphony orchestra and a tape-recorded version of the same should have been in the San Francisco War Memorial Opera House on Saturday evening, March 3, and many were. As listed on the program for the evening, the occasion was "A Premiere in Sound" featuring the San Francisco Symphony Orchestra, Enrique Jorda, conductor, presented by the San Francisco Symphony Association in cooperation with the San Francisco Symphony Foundation, the Ampex Corporation, and the Musicians' Union, Local No. 6, A. F. of M.

As the house lights dimmed, Maestro Jorda took his position on the podium, raised his arms and gave the downbeat for the orchestra to swing into the overture of "The Marriage of Figaro" by Mozart. Or at least, seemed to. Because shortly, the orchestra lights dimmed, spotlights picked out an array of three big charcoal-gray loudspeaker units on the stage, the musicians ceased their pantomime, and the hoax was clear. The program material was actually coming from a rack-mounted three-channel stereo tape unit at stage left.

Considerable whimsy was carried into the staid Opera House that night together with the extensive display of gear ministered to by Walter T. Selsted and William L. Cara, who served as recordists. The first half of the program was concluded with an impromptu session where a few individuals from the orchestra heard themselves played back in solo and duet spots, including a bassoonist accompanying himself on a prerecorded bassoon passage. Ultimately, the percussion group, after hearing themselves faithfully played back in a seriatum performance of bells, cymbals, drums, and gong, rejoined by belaboring their various instruments in chorus. In response to this challenge, the recordists admitted a mock defeat by setting off a small explosive charge on the top of each speaker.

That the voice coils were still intact was shown by the second item after the intermission. As described by Ross H. Snyder, narrator, the real A/B consisted of the Fourth Movement of "Scheherazade" by Rimsky-Korsakoff played in continuous segments by the orchestra and by the stereo equipment alternately.

In this severe test the fidelity was indeed impressive, though in the heavy percussion passages there were evidences of the truth of the earlier mock surrender. At least in the section of two-dollar seats where the stage tends to approach a point source anyway, opinion seemed to lean toward the feeling that the live and recorded portions were not entirely indistinguishable.

*Solo for Iron-Oxide Particles*

Following "Scheherazade," the orchestra presented "Rhapsodic Variations for Tape Recorder and Orchestra" by Ussachevsky-Luening. This represented a piece in which the tape recorder moved from its role as a reproducing instrument into that of a solo device. Dr. Ussachevsky was on hand to operate the console unit. It

would be interesting to see what the notation in an orchestral score for tape recorder looks like.

In any event, the resulting music was always interesting, and sometimes quite moving. As might be expected, the sounds provided by the recorder were generally of a character which would be difficult or conceivably impossible to produce from the instruments of a normal orchestra. These ranged from massive bell-like reverberations through chattering sounds similar to what one might expect in a jungle, to deep windy sighs somewhat like a steam locomotive emerging from a tunnel.

As the program pointed out, careful calculation permits regular cueing of the tape recorder by the conductor, providing a blending of unusual sound patterns superimposed on top of the orchestral fabric. The audience appeared to enjoy the performance, taking this combination seriously enough, except for a couple of the Doppler-type sighs, which evoked a certain amount of merriment where they tended to suggest Gargantuan expressions of astonishment.

*Technical Details*

Microphones used were Altec Model 21-B, suspended approximately eleven feet above the front of the orchestra, and spaced laterally at one-sixth, one-third, one-third, and one-sixth of the width of the orchestra. These were controlled through a ganged three-channel precision-stepped attenuator system, to the three individual electronic recorder chasses of an Ampex Model 300–3 stereophonic tape recorder especially fitted with the necessary means of handling one-half-inch tape, and with special magnetic heads for the recording of three separate and simultaneous tracks on the tape, each 100 mils in width.

The machine operated at 30 inches per second. Each of the three electronic chasses fed the recorded output to an Ampex Model 6516 30-watt power amplifier, and each of these was connected to an Ampex Model 5050 theater loudspeaker system, consisting of two 15-inch low-frequency speakers, one wide-angle high-frequency horn, and horn-loading enclosure.

Between the tape recorder electronic chassis and the power amplifiers was inserted a custom-built equalizing network, whose purpose was to tailor the sound precisely so as to compensate for the individual departures from ideal performance of both the microphones and loudspeakers used.

**Syracuse, N.Y.**

The following report was prepared by W. W. Dean, Secretary of the Syracuse Chapter, IRE-PGA:

"Syracuse has given the Professional Group on Audio excellent support during the first year of its existence. To date the Syracuse PGA Chapter has held or sponsored nine meetings, with an average attendance of 60. When the chapter was organized there were 30 PGA members in the Syracuse Section; in one year that number has increased to about 65!

We have been very privileged in having as speakers at our meetings during the past year some of the most outstanding audio engineering and physicists in the country, including Dr. Winston E. Kock of Bell Labs., Dr. Peter C. Goldmark of CBS, Dr. D. E. Wiegand of Armour Research Foundation, William S. Bachman of Columbia Records, and Syracuse audio specialists, Roy Dally, A. F. Petrie, and S. Zuerker. In at least two instances, our Syracuse Audio group has been the very first in the country to hear the engineering details of significant developments in the audio field. For example, Dr. Goldmark spoke to us last December on the Automobile phonograph, "Highway Hi-Fi," and Mr. Petrie described the design and performance of the distributed-port type loud-speaker enclosure to us last spring. Both of these men have just presented this same information at the 1956 IRE National Convention. At our next and final meeting for this season we will also have a very widely-known audio engineer with us, Norman C. Pickering of Pickering and Company.

We are nominating a slate of officers for the next year and are taking preliminary steps to line up an excellent program for 1956–1957.

Membership activity is not being neglected. We are canvassing the Syracuse IRE for more PGA signs-ups and are providing two incentives for early action: 1) a free copy of Part VII of the 1956 IRE CONVENTION RECORD and 2) a drawing for a valuable record album to be given at our May meeting."

**Washington, D.C.**

On April 18, Albert Preisman, of the Capitol Radio Engineering Institute, spoke on the general subject of High Fidelity. He discussed the progress being made by leading manufacturers of pickups, loud speakers, amplifiers and other high fidelity components toward making sound systems more life-like.

Mr. Preisman also described the Soundarama demonstration held at Constitution Hall in Washington, D. C. Preliminary tests were made in the auditorium to check sound distribution and orchestra peak levels for empty and full house. This indicated the need for 200 electrical watts input. Ten 50-watt Fisher amplifiers and ten Jensen Imperial speakers were used. Tests were made of the overload characteristics of these speakers at various frequencies. Four Berlant tape recorders and a Western Electric 640-AA condenser microphone with other microphones were used in Maxfield and other arrangements.

Albert Preisman is currently associated with Capitol Radio Engineering Institute as Vice-President in Charge of Engineering, and is engaged as consulting engineer for the Military Service as well as for civilian corporations. Since 1924 he has been active in the electronic

field, having been associated with the Wagner Electric Corporation, New York Edison Company, RCA Photophone, RCA Institutes, and the Federal Telephone and Radio Corporation.

He is the holder of several patents, has made many contributions to leading technical journals, and is the author of "Graphical Constructions for Vacuum Tube Circuits."

Mr. Preisman is a fellow of the IRE, and a member of several scientific and technical societies, including AIEE, ASEE, the Acoustical Society of America, and Sigma Xi.

## WITH OTHER ACOUSTICAL AND AUDIO SOCIETIES

The January, 1956 issue of the *Journal of the Acoustical Society of America* contains nineteen articles and six Letters to the Editor. The following are deemed to be of principal interest to the Audio Technologist.

"Absorption Characteristics of Upholstered Theater Chairs and Carpet as Measured in Two Auditoriums," by R. N. Lane, Defense Research Laboratory, The University of Texas, Austin, Texas. "Data on the absorption of upholstered theater chairs as measured during the construction of a 496-seat auditorium and a 738-seat auditorium are presented. These data obtained on the seats after placement in each auditorium indicate a much lower absorption per seat over the entire audio-frequency band than has previously been reported. Before the seats were installed in the 496-seat auditorium, 1080 ft.$^2$ of Axminster carpet were laid on the floor of this room, and the absorption characteristics of this full scale sample were determined. These data are also reported in this paper."

"Automatic Extraction of Formant Frequencies from Continuous Speech," by James L. Flanagan, Acoustics Laboratory, Massachusetts Institute of Technology, Cambridge, Massachusetts, and Air Force Cambridge Research Center, Cambridge, Massachusetts. "Two electronic devices for automatically extracting the first three formant frequencies from continuous speech are described. Both devices are designed to yield three continuous dc output voltages whose magnitudes, as functions of time, represent the formant frequencies of the input speech. The principles of operation and the design features of both devices are discussed, and typical examples of the operation of each are presented."

"Note on the Calibration of Disk Recording by Interference Patterns," by P. E. Axon and W. K. E. Geddes, British Broadcasting Corporation, Balhma, London S. W. 12, England. "Both the sets of interference fringes described by Mr. B. B. Bauer in his paper 'Calibration of Test Records by Interference Patterns' [27,586 (1955)] will be found to be situated in the plane in which the unmodulated disk groove, considered as a cylindrical mirror, forms an image of the light source."

"Ultrasonic Irradiation of the Central Nervous System at High Sound Levels," by William J. Fry and Floyd Dunn, Bioacoustics Laboratory, University of Illinois, Urbana, Illinois. "High level ultrasound produces, under properly controlled dosage conditions, selective changes in the central nervous system. The physical mechanism of the action of the sound requires elucidation. Some of the problems associated with determining the physical mechanism are discussed and a preparation and procedure are described which are appropriate for accurately determining dosage relations for such a study. The quantitative results obtained with this preparation are presented."

"Historical Note on the Haas Effect," by R. D. Fay, Acoustics Laboratory, Massachusetts Institute of Technology, Cambridge, Massachusetts, and W. M. Hall, Engineering Division, Raytheon Manufacturing Company, Newton, Massachusetts. "The writers' attention has been called to a tendency, particularly among persons more recently introduced to the problems of sound re-enforcing systems, to consider the phenomena now known as the Haas effect as something just recently discovered and understood. It may be of interest to members of the Society that one aspect of the phenomena was reported at the fourteenth meeting of the Society held at Harvard University, December 6–7, 1935."

The issue contains its usual excellent references to contemporary papers on acoustics by Robert W. Young, "Review of Acoustical Patents." The program of the fiftieth meeting of the Acoustical Society held in Providence, R. I. in December, 1955 together with the abstracts of all papers is included. One of these abstracts is especially interesting.

"Sones, Spectra, and Summation," by S. S. Stevens, Psycho-Acoustic Laboratory, Harvard University, Cambridge 38, Massachusetts. "The current assumption that the loudness in sones of a noise is the sum of the loudnesses in the separate octave bands is shown under direct test to be grossly wrong. These tests show that the loudnesses in octave bands can be combined according to the formula $S_t = S_m + F(\sum S - S_m)$ where $S_t$ is the loudness (in sones) of the total noise, $S_m$ is the loudness of the loudest band, $\sum S$ is the sum of the loudnesses of all the bands, and $F$ is a factor that may vary between zero and one. It turns out that under a wide variety of conditions the factor $F$ has the value of 0.27. Consequently, the rule for combining the loudnesses in octave bands is simply this: to the loudness in sones of the loudest band add 0.27 times the sum of the sones in the remaining bands."

We will look forward with interest to the publication of the full paper by Dr. Stevens.

The July, 1955 issue of the *Journal of the Audio Engineering Society* contains 7 papers, all of which are of interest to Audio Technologists.

"Transient Behavior of Electric Wave Filters," by Leslie Norde, Motorola Research Laboratory, Phoenix, Arizona. "A present-day technique of solving transient problems by means of tables of transform pairs is here discussed. With the aid of these tables, the solution of the network differential equations is reduced to relatively simple algebraic manipulations. The complete results of such solutions yield not only the transient terms but the steady-state solutions as well."

"Power Amplifiers for Music Reproduction," by Hermon H. Scott, Hermon Hosmer Scott, Inc., Cambridge, Massachusetts. "A *snubber* circuit has been developed that does not affect the power-handling capacity of the amplifier on music waveforms but which protects the loudspeaker from continuous high power levels. A system is described which, while providing adjustable output impedance with adversely affecting amplifier performance, allows optimum damping for all types of loudspeakers."

"Locating Defects in Magnetic Recording Tape," by Andreas Kramer, Audio Devices Inc., New York, New York. "This paper describes an instrument for making instantaneous uniformity-of-response tests by locating and registering the number of individual cycles of output voltage whose amplitudes are below a preset level."

"Measurement of Flutter and Wow in Magnetic-Tape Instrumentation Recorders," by John T. Mullin, Bing Crosby Enterprises, Hollywood, California. "Specifications for all tape recorders for professional and instrumentation applications include performance figures with regard to flutter and wow. Techniques of measurement give divergent results. The method employed in the authors's organization is described, and a comparison is made of results obtained by this method and other methods of less precision."

B. B. BAUER

# Magnetic Recording—1888-1952*

CARMEN F. WILSON†

*Summary*—**Thirty-eight of the more important patents, from more than five hundred that were investigated, have been listed along with a complete bibliography of magnetic recording covering the years 1888–1952.**

## PREFACE

THIS LIST was originally prepared to meet repeated requests of the Technology Department of the John Crerar Library for material on the subject of magnetic recording and in its first edition covered the years 1900–1949. In this revised edition the period of coverage has been expanded to 1888–1952 and the number of references has about doubled in number over the original bibliography. Every attempt has been made to make the bibliography complete for published literature through the years cited, tracing the history, growth, and applications of magnetic recording. References have been supplied with short descriptive annotations or abstracts whenever possible. Abstracts have been taken from several sources including the *Engineering Index*, *Science Abstracts*, *U. S. Offices of Technical Services Bibliography of Scientific and Industrial Reports*, various abstracting sections in journals, summaries at the beginning of articles and, in many cases, have been supplied by the compiler. Sources are hereby gratefully acknowledged.

Selection of patents was made, after examination of approximately 500 patents in the field of magnetic recording, by S. F. Molnar, Computer Development Section, Armour Research Foundation, Chicago. The patents were selected to represent the major changes in the art of magnetic recording but do not purport to be complete or to include all patents which the courts might call pioneer patents. Many thanks go to Mr. Molnar for his interest and encouragement as well as the many hours he spent reading and weighing abstracts in the *U. S. Patent Office Official Gazette*. Descriptions of patents have been omitted because of the increased bulk they would have necessitated in the bibliography. The year 1952 was decided upon as a stopping point because the literature on the subject is now generally well indexed and becoming more and more voluminous as time goes on.

The arrangement is chronological by date of publication and alphabetical by author within each year. The compiler hopes it will be useful and helpful to all those interested in the subject.

* Manuscript received by the PGA March 12, 1956.
† Technology Dept., John Crerar Library, Chicago, Ill.

## MAGNETIC RECORDING PATENTS

Poulsen, Valdemar. Method of recording and reproducing sounds or signals. U. S. Patent 661, 619. Filed July 8, 1899. Granted Nov. 13, 1900.

Rosenbaum, William A. Apparatus for electromagnetically recording speech. U. S. Patent 720,621. Filed June 22, 1901. Granted Feb. 17, 1903.

Poulsen, Valdemar. Apparatus for electromagnetically receiving, recording, reproducing, and distributing articulate speech, etc. U. S. Patent 788,728. Filed Aug. 14, 1901. Granted May 2, 1905.

——— Pedersen, Peder O., and Schou, Carl. Telegraphone. U. S. Patent 789,336. Filed Sept. 2, 1902. Granted May 9, 1905.

Manwaring, George A. Talking-machine. U. S. Patent 793,140. Filed Jan 12, 1904. Granted June 27, 1905.

Poulsen, Valdemar. Apparatus for effecting the storing up of speech or signals. U. S. Patent 822,222. Original application filed July 8, 1899. Divided and this application filed April 3, 1900. Renewed March 20, 1906. Granted May 29, 1906

Pedersen, P. O. Magnetizable body for the magnetic record of speech, etc. U. S. Patent 836,339. Filed June 21, 1901. Granted Nov. 20, 1906.

Poulsen, Valdemar. Telegraphone. U. S. Patent 873,084. Filed Sept. 29, 1902. Renewed May 2, 1907. Granted Dec. 10, 1907.

Stuart, Harve R. Telegraphone. U. S. Patent 890,195. Filed Sept. 24, 1907. Granted June 9, 1908.

——— Telegraphone. U. S. Patent 893,277. Filed July 3, 1907. Granted June 14, 1908.

Kirkegaard, Georg. Sound recording and reproducing instruments. U. S. Patent 900,392. Filed Nov. 18, 1899. Renewed March 5, 1908. Granted Oct. 6, 1908.

Hytten, Ejnar A. Telegraphone apparatus. U. S. Patent 909,414. Filed Dec. 31, 1907. Granted Jan. 12, 1909.

Clement, Edward E. Method of recording and reproducing sounds or signals. U. S. Patent 1,011,322. Filed Nov. 14, 1905. Renewed March 22, 1910. Granted Dec. 12, 1911.

Haines, John H. J. Telegraphone. U. S. Patent 1,079,123. Filed Feb. 3, 1910. Granted Nov. 18, 1913.

De Forest, Lee. Apparatus for and method of recording fluctuating currents. U. S. Patent 1,177,848. Filed June 24, 1913. Divided and this application filed June 23, 1915. Granted April 4, 1916.

Bullis, Henry C. Method of producing magnetic sound-records for talking-motion-picture films. U. S. Patent 1,213,150. Filed Dec. 15, 1915. Granted Jan. 23, 1917.

Fuller, Leonard F. Method of sensitizing the telegraphone. U. S. Patent 1,459,202. Filed Aug. 26, 1918. Granted June 19, 1923.

Cothran, Edward Everett. Sound recording and reproducing device. U. S. Patent 1,588,706. Filed Nov. 23, 1922. Granted June 15, 1926.

Rhodehamel, Carl W. Magnetic record wiper. U. S. Patent 1,837,586. Filed Feb. 4, 1929. Granted Dec. 22, 1931.

Nakken, Theodorus H. Pick-up apparatus for magnetic films. U. S. Patent 1,882,336. Filed May 21, 1929. Granted Oct. 11, 1932.

Alverson, James G. Magnetic sound recording system. U. S. Patent 1,886,616. Filed March 30, 1931. Granted Nov. 8, 1932.

Gedeschi, Gaetano, and Monti, Gaetano. Process and apparatus for registering and reproducing sounds. U. S. Patent 2,053,760. Filed July 31, 1934. Granted Sept. 8, 1936.

Heller, Herman S. Magnetic sound recording and monitor system. U. S. Patent 2,213,246. Filed Oct. 25, 1937. Granted Sept. 3, 1940.

Clopton, Alexander. Recording and reproducing device and method. U. S. Patent 2,263,485. Filed Aug. 14, 1940. Granted Nov. 18, 1941.

Camras, Marvin, and Korzon, William. Recording and reproducing of vibrations. U. S. Patent 2,351,003. Filed Sept. 11, 1940. Granted June 13, 1944.

Camras, Marvin. Magnetic recording head. U. S. Patent 2,351,007. Filed Aug. 10, 1942. Granted June 13, 1944.

Spears, Morton F. Magnetic recording and reproducing system. U. S. Patent 2,357,582. Filed July 27, 1950. Granted Sept. 11, 1951.
Begun, Semi Joseph. Apparatus and method for magnetic recording. U. S. Patent 2,419,195. Filed June 16, 1944. Granted April 22, 1947.
——— Magnetic recording-reproducing means and systems. U. S. Patent 2,424,218. Filed Jan. 30, 1943. Granted July 22, 1947.
Burns, Leslie L. Device for reproducing magnetic records. U. S. Patent 2,536,260. Filed Dec. 30, 1948. Granted Jan. 2, 1951.
Somers, Richard M. Reel-type phonographic machine. U. S. Patent 2,536,666. Filed Jan. 4, 1947. Granted Jan. 2, 1951.
Stone, Burnham E. Tape runout control for magnetic recorders. U. S. Patent 2,543,590. Filed Jan. 7, 1950. Granted Feb. 20, 1951.
Hehr, Frederick G. Sound recording and reproducing apparatus. U. S. Patent 2,547,464. Filed March 3, 1950. Granted April 3, 1951.
Camras, Marvin. Binaural magnetic recorder. U. S. Patent 2,561,338. Filed Dec. 31, 1946. Granted July 24, 1951.
Thad, Theodore D. Ruling control system for recorders. U. S. Patent 2,567,158. Filed July 15, 1949. Granted Sept. 4, 1951.
Pettus, James L., and Pontius, Frank E. Magnetic head and mount therefor. U. S. Patent 2,574,707. Filed Dec. 29, 1948. Granted Nov. 13, 1951.
Smith, Thomas C., Hart, Frederick H. M., and Freer, William A. Sound film drive and guide. U. S. Patent 2,577,162. Filed April 14, 1946. Granted Dec. 4, 1951.
Haynes, Nathan M. Magnetic recording apparatus. U. S. Patent 2,628,287. Filed Feb. 16, 1951. Granted Feb. 10, 1953.

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Includes patents (U.S.) submitted by the inventor Patrick B. Delany describing, respectively, means for handling receiving tape; means for utilizing the static charge of the circuit; receiving tape for chemical telegraphs; transmitting and receiving apparatus; telegraphic tape recording and an electromagnetic perforator.]

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Hickman, C. N., "Delayed Speech." *Bell Laboratories Record*, Vol. 11, p. 308; June. Utilizing the principles of magnetic recording, a method has been developed which delays speech of any value from a fraction of a second to several minutes.

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1935

Braunmuhl, H. J. von, "Sound Recording in Broadcasting." *Funktechnischer Vorwärts*, Vol. 5, no. 4; 1935.

Hamilton, H. E., "The Blattnerphone, Its Operation and Use." *Electrical Digest*, p. 347; December.

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phenomena taking place in magnetization process during recording; reproduction of magnetic tone carriers.

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Wiegand, D. E., "A Study of Magnetic Recording." Dissertation, Electrical Engineering Department, University of Illinois. The magnetic recorder of telegraphone is a sound recording system based on those properties of hard steel which permit it to receive and retain fixed magnetic impressions.

1936

Begun, S. J., "Die neue Stahlton-Bandmaschine." *Lorenz Berichte*, no. 1, p. 3; January. "An Experimental Telegraphone." *Mechanics and Handicraft*, pp. 90–93, 104; July.

Lehmann, H., "Der DVL-Ruderausschlagschreiber R11/8 m und seine Flugerprobung (The DVL-Rudder Deflection Recorder R11/8 m and Its Flight Test)." ZWB Forschungsberichte 644 PB 38249, 6 p. The "DVL E, V. Berlin-Adlershof" developed the deflection recorder and tested it on aircraft model Albatros L 75. The recorder has a paper tape of 8 m length and feeding speed of 10 mm/s. This German report includes photographs of the apparatus and an actual flight recording diagram.

"Magnetic Recording of Sound; Lorenz Steel Band Recorders." *Wireless Engineer*, Vol. 13, pp. 175–78; April. Mechanical and electrical details of Lorenz Co.'s steel band recorders as used by German broadcast stations at present; steel band is 3 mm wide and 0.08 mm thick and wound off one drum onto another; usual length runs for 30 minutes.

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Okuno, H. and others, "On Magnetic Recording." *Institute of Electrical Engineers Japan Journal*, Vol. 56, pp. 416–17 (In Japanese).

Schrage, W. E., "Sound Recording on Magnetic Materials." *Radio Craft*, Vol. 7, pp. 537–62; March

Schuller, E., "Magnetophone." *Verein Deutscher Elektrotechniker Fachberichte*, pp. 175–77.

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Begun, S. J., "Magnetic Recording-Reproducing Machine for Objective Speech Study." *Society of Motion Picture Engineers Journal*, Vol. 29, pp. 216–18; August. Magnetic recording, as the ideal medium for objective voice study and training, is discussed.

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Hickman, C. N., "Magnetic Recording and Reproducing." *Bell Laboratories Record*, Vol. 12, pp. 2–7; September. Improvement of Poulsen system by Bell Laboratories consists in providing better magnetic material, in rolling it into thin tape, and in properly heat treating it; with tape, twisting tendency is avoided so that perpendicular magnetization can be employed, with two poles placed directly opposite each other.

——— "Sound Recording on Magnetic Tape." *Ibid.*, Vol. 16, pp. 165–77; April. Improved method of recording sound magnetically on steel tape, similar in principle to that of Poulsen telegraphone; system makes use of perpendicular magnetization; this method makes it possible, with suitable equalization, to obtain substantially uniform frequency response characteristic up to 8,000 cps with tape speed of only 16 inches per second. Bibliography.

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Nagai, Kenso and others, "Studies of Noise and Recording Materials for Magnetic Recording." *Nippon Electrical Communication Engineering*, no. 7, pp. 218–24; August. Causes of noise; wave forms of noise and new method for erasing; requirements for magnetic recording materials and materials used for experiment; equipment and conclusion. (From *Institute of Telegraph and Telephone Engineers Journal*, no. 161; August, 1936.)

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Barrett, A. E., and Tweed, C. J. F., "Some Aspects of Magnetic Recording and Its Application to Broadcasting." *Institution of Electrical Engineers Journal*, Vol. 82, pp. 265–85; March. (Discussion) pp. 285–88. Technical and program service requirements for recording system for use in connection with broadcasting, and description of recording channel at British Broadcasting Corp. premises at Maida Vale; simplified consideration of processes occurring in magnetic recording of sound on steel tape and description of some of apparatus and methods used in its application to broadcasting.

Begun, S. J., "Magnetic Recording." *Electronics*, Vol. 11, pp. 30–32; September. Characteristics of recording on magnetic material, such as steel tape or wire; description of machine with suggestions for its application.

——— and Wolf, S. K., "On Synthetic Reverberation." *Communications*, Vol. 18, pp. 8–9; August. Explains how an endless steel tape or film recording (with several pick-ups) can be used for purposes of synthetic reverberation.

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Malloy, T. J., "Magnetic Recorder for Recording Sound on Steel Wire." *Electronics*, Vol. 11, pp. 30–32; January. Questions relating to recording broadcast programs or other material on wire answered by description of working equipment developed by the author.

Nagai, Kenzo and others, "Experimental Consideration Upon the A-C Erasing on the Magnetic Recording and Proposition of the New Recording Method." *Denki Gakkwai*, Tokyo (*Institute of Electrical Engineers of Japan Journal*) no. 180; March. Also seems to appear in *Nippon Electrical Communication Engineering*, no. 13.

"Steel-wire Recording of Sound as a General Commercial Possibility—the Textophone." *Electrician*, Vol. 121, p. 795. Short description of new piece of commercial equipment.

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1939

Aldous, D. W., "Steel Tape Recording—the Textophone." *Wireless World*, Vol. 44, pp. 611–12; June 29. Describes a combined recording and reproducing instrument modeled on that used for many years by the B.B.C. Various refinements have been added, the most important being provision for direct connection to the G.P.O. telephone circuit for recording conversations without the intervention of a microphone or of the G.P.O. telephone earpiece.

"B.B.C. Recording Service." *Electrician*, Vol. 122, pp. 303–04; March 10; *Electrical Review* (London), Vol. 124, pp. 385–86; March 17. An evaluation of the three methods (steel tape, disc, and film) de-

veloped over a six year period by the British Broadcasting Corporation.

Begun, S. J., "A New Magnetic Recorder and Its Adaptations." *Society of Motion Picture Engineers Journal*, Vol. 33, pp. 538–547; November. A very brief history of magnetic recording together with a description of recently developed equipment in the field.

Carnegie-Illinois Steel Corporation, "Standard Definitions of Terms, with Units and Symbols Relating to Magnetic Testing." *Technical Bulletin*, no. 1, pp. 95–97.

Irish, S. R., "Magnetic Recording of Sound." *Cornell Engineer*, Vol. 5, pp. 5–7, 26+; November. Traces the history and describes the basic scientific principles of magnetic sound recording.

Legg, V. E., "Survey of Magnetic Materials and Applications in the Telephone System." *Bell System Technical Journal*, Vol. 18, pp. 438–64; July. Mentions the magnetic tape recorder application.

Meyer, E., *Electro-acoustics*. London, G. Bell and Sons, 1939. pp. 79–85. A brief description of magnetic receivers (steel tape and iron powder film-band).

"Recording on Steel Tape." *Wireless World*, Vol. 44, pp. 611–12; June 29. Combined recording and reproducing instrument for use in offices described; various refinements added, most important being provision for direct connection to circuit for recording conversations without intervention of microphone or telephone earpiece.

Washburne, R. D., "Sound-on-Wire Tape." *Radio Craft;* May.

Wolf, S. K., "Artificially Controlled Reverberation." *Society of Motion Picture Engineers Journal*, Vol. 32, pp. 390–395; Discussion, pp. 395–397. In the recording, acoustical, and electrical transmission of sound, the control of reverberation for purposes of speech articulation, musical quality, and acoustic illusion has been one of the problems confronting architects, broadcasting, recording, and acoustic engineers for some time. The paper discusses briefly the phenomenon of reverberation and describes two methods of reverberation control: 1) reverberation chambers and 2) a practical machine employing magnetic recording.

1940

Blaupunkt-Werke, "Investigations on a Magnetic Recording Device for 20 Kilocycles." (Untersuchungen zu einer magnetischen Registriervorrichtung fur 20 K KHZ). PB54174. November. The phase direction finder determines the direction of the incoming electromagnetic wave from the phase differences. These, the phase differences, are recorded magnetically with audio-frequency and then subsequently measured in a compensation wiring. Abstract prepared at Headquarters Air Material Command Wright Field, Dayton, Ohio.

Darragh, J. B., "Flight Test Data Mechanically Recorded; Pilot's Oral Report During Test is Recorded on Steel Tape; Planetest Magnograph." *Aero Digest*, Vol. 37, pp. 96+; September.

Mansi, R. L., "Construction of Apparatus for Recording Sound on Steel Wire." *Electronics and Television and Short Wave World*, pp. 4–10; January; pp. 69–74; February; pp. 142–44; March. A series of three articles on the construction of apparatus for recording sound on steel wire. Preliminary details, actual details of the machine and amplifier, and instructions for recording, playing back and wiping out are given.

Nagai, Kenso, and Nishima, T., "Magnetic Sound-Recording Materials." *Nihon Nickel Joho*, (*Japan Nickel Review*) Vol. 8, pp. 256–64; October. Requirements necessary for magnetic recording materials; classification of recording elements according to shape and composition; requirements of core materials (In Japanese and English).

"Recording on Film." *Barron's*, Vol. 20, p. 5; September 30. News item.

"Telegraphone." *English Mechanics*, p. 411; April 5. Brief replies to queries about the telegraphone.

1941

Begun, S. J., "Magnetic Recording and Some of Its Applications in Broadcast Field." PROCEEDINGS OF THE IRE, Vol. 29, pp. 423–33; August. Paper deals with three essential processes of magnetic recording; obliterating, recording, and reproducing of record; magnetic material used is discussed, also necessary electrical and mechanical requirements for obtaining desired frequency and dynamic range; applications of magnetic recording systems by European broadcast stations for program delay. Bibliography.

Brush Development Co., Cleveland, *Development of a High Frequency Strain Analyser*. First report. (National Defense Research Committee Report D-3-212) PB 32604. 15 p. n.d. This report considers some of the electrical design and materials problems in the development of a high frequency strain analyzer. A high frequency transient recorder which covers a range from 100 to approximately 30,000 cycles is wanted. Transients having components falling within this range must be reproduced in such a way as to form a facsimile of the original. To meet this requirement, it is necessary to cover the above frequency range without amplitude or phase distortions. A tungsten steel magnetic tape, joined to form an endless tape is considered. Experimental investigations of the high frequency characteristics obtained in magnetic recording and reproducing were carried on with a simple driving mechanism which is described. The influence of widths and material in pole pieces, circuits, recording and reproducing heads and other components are discussed. A method for electroplating of beryllium copper tape with cobalt-iron magnetic alloys is worked out. Curves and diagrams are included.

Coldby, J., "Electronic Technique of Making Talking Pictures; How The Sound Part is Produced on Film." *Radio News*, Vol. 25, pp. 8–10, January. The inside story of how sound is produced on film for talking pictures.

Heidenwolff, H., "Verfahren zur mikroskopischen Sichtbarmachung magnetischer Tonaufzeichnungen." *Lorenz-Berichte*, no. 3/4, pp. 119–22; December. Method of making magnetic sound recording visible microscopically; use of optical medium consisting of 300 volumetric parts glycerine or paraffin oil and one part of finest iron powder; results shown in series of photomicrographs of steel wire modulated at different frequencies.

Rich, E. S., *Report on a Method of Obtaining Artificial Reverberation Using a Magnetic Tape Recording System*. Brush Development Co.; January.

Wolf, S. K., "Synthetic Production and Control of Acoustic Phenomena by a Magnetic Recording System." PROCEEDINGS OF THE IRE, Vol. 29, pp. 365–71; July. In recent years there has been an increasingly active search for an electroacoustic system for producing and controlling reverberation and associated phenomena. This paper describes an electromagnetic method of producing and controlling reverberation by the use of a magnetic tape recording system. It consists of recording a sound pattern magnetically on steel tape. The signal is picked up from the tape at frequent split-second intervals and reproduced at any desired level or characteristic. The tape is arranged for driving in an endless helical loop. An obliterating head which continuously obliterates the record is placed just before the first recording head. The phenomena of reverberations and the various methods which have been suggested by others for controlling reverberation synthetically, such as the electro-optical, electromechanical, mechanical-recording, and the reverberation-chamber methods, are briefly discussed. The paper also outlines other uses for the magnetic tape system in the study of acoustic phenomena both synthetically and analytically.

1942

Brush Development Co., Cleveland, *Development of a High Frequency Strain Analyser*. Second report. (National Defense Research Committee Report D-3-256) PB 32605. 27 p.; July, 1942. This second report on the development of a high frequency strain analyzer discusses methods of magnetic sound recording and an experimental investigation of the influence of increasing the tape speed and also the influence of eddy currents. In the different frequency response curves, the upper frequency recording limit is raised in proportion to the increase in tape speed. The causes of low frequency cutoff and of low frequency distortion are studied. Method of phase shift measurement, with the idea of phase shift elimination is also investigated. Methods of compensating that time delay are worked on. The one tried was a rerecording process which permits cancelling of the phase shift effects present in both the recording process and associated apparatus. Curves, photographs and diagrams are included.

——— *Development of a High Frequency Strain Analyser*. Third report. (National Defense Research Committee Report D-3-305) PB 32606. 16 p. September, 1942. The third report on the development of a high frequency strain analyzer discusses first the question of increasing the dynamic range of recording. The use of push-pull recording and the application of a pilot frequency were discarded. Investigation of heat-treated magnetic alloys for plating the tape included cobalt-steel, tungsten-steel, and platinum-cobalt alloy. A

new design of a special magnetic ring head is worked out. The preliminary model of the high frequency transient recorder designed to work over a frequency range of from 400 to 40,000 cycles, with two independent channels and with tape loops is described. Curves, photographs, and diagrams are included.

Camras, Marvin, "Magnetic Recording on Steel Wire." Master of Science Degree, Illinois Institute of Technology. 1942, 96 pp., diagrams, bibliography.

I. G. Farbenindustrie A. G., Frankfurt/M. Magnettonband (Magnetic sound strip containing particles of magnetizable material in a binding agent). Registered design 1520 543/42g dated March 14, 1942. Frames 23–25. Application for registered designs. *FIAT Microfilm Reel E 7, 1937–1942.* PB L 70412.

Klangfilm G. M. B. H., Berlin. Magnetogrammführung (Magnetogram guide for sound recording). Registered design 1520 50 g/42g dated April 2, 1941. Frames 1–3. Application for registered designs. *FIAT Microfilm Reel E 7, 1937–1942.* PB L 70412.

"Magnetic Recording on Steel." *Radio News*, Vol. 28, p. 42; September. A news item regarding the new method of recording on hair-thin wire as worked out by Marvin Camras of the Armour Research Foundation.

"Mirrophone." *Wireless World*, Vol. 48, pp. 42–43; February. Description of magnetic recorder built by Western Electric, using steel tape of special alloy developed by Bell Telephone Laboratories; in reproduction recording magnet serves as pick-up device; device is suitable for public speaking classes and music schools.

Wildbolz, H., "Das Textophon." *Schweizer Archiv*, Vol. 9, pp. 9–12; October (supp.) Illustrated description of Textophone, modern office instrument and management tool; it uses steel wire instead of steel tape, which functions as high grade permanent magnet; life of wire is in no way affected by magnetic recording or reproduction, and same wire can be used for years; nontechnical review of diversified applications of device, for correspondence, telephone communications, conference recording, etc.; its primary use is as a dictaphone.

1943

Brush Development Co., Cleveland, "Fourth Report on the Development of a High Frequency Strain Analyser." (Office of Scientific Research and Development Report 1615) PB 24884. 5 p. June.

——— "Sound Recording on Magnetic Materials." Office of the Publication Board Report. PB 6559. 11 p. Dec. 1, 1943. The work described in this report pertains to the development, design and construction of a small portable recording in the approximate size of a portable motion picture camera. In preference to other means of recording, magnetic wire recording was chosen for the following reasons: 1) mechanical vibrations do not seriously interfere with the recording or reproducing processes; 2) the space occupied by wire is a minimum for any required time of recording, as compared to that required by other media; 3) little power is needed to make a recording; 4) the signal can be reproduced many times without deleterious effects on the recording; and 5) the signal can be erased and the medium reused. In order to eliminate the weight of batteries to supply running power for the reels, a spring driven mechanism of the motion picture type was selected. Report contains details of recorder, wire, erasing and recording process, head, self contained playback amplifier, housing, and 12 volt auxiliary drive. Photographs are attached. For a revision of this report, consult PB 6558.

Camras, Marvin, "A New Magnetic Wire Recorder." *Radio News*, (Radionics Section 1) Vol. 30, pp. 3–5, 38–39; November. An analysis of recording and reproducing with steel wire and its advantages compared with former tape recorders.

Hanson, R. O., *Magnetic Wire Recorders: General Electric Model 20A, Armour Research Model 50.* (Columbia University Division War Research Memo P37/R656. PB L 81052. 11 p. December. At the request of BuZero, tests were made by the New London Laboratory on the General Electric Model 20A and the Armour Research Model 50 Magnetic Wire Recorder. This file memorandum gives a detailed description of the two recorders, followed by data on comparison between the two models. Frequency in cycles per second for both models and a circuit diagram for Model 50 are included.

Herrnfeld, F. P., *Oscillator (125 kc) for Use with High Fidelity Tape Recorder.* (Columbia University Division of War Research Report D13/R344) PB L 81359, 4 p.; May. This memorandum describes the subject oscillator unit and also gives the electrical specifications. A unit drawing 12937BE is included.

Jones, C. B., and Davies, D. B., *Sound Recording on Magnetic Materials.* (Office of Scientific Research and Development Report 3099). Office of the Publication Board Report. PB 6558. 15 p. December 1, (Rev. December 30). This report is a revision of material contained in PB 6559. In addition to the original information on the magnetic wire recorder, data is given here on performance. Additional photographs and a frequency response curve on sound pressure in ear of observer for 1 rms volt on terminals of T-45 microphone after reproducing through recorder D-103 using DJ phone are also included. The work of developing a small portable recorder was done at the Brush Development Co., Cleveland, Ohio.

"Magnetic Wire Recorder Preserves Running Account of Observation Flight Battle Description on Steel Wire." *Life*, Vol. 15, pp. 49–50; November 1.

Olson, A. O., "Magnetic Recording of Sound." *Home Movies*, Vol. 10, pp. 219, 330–31; October.

——— "Magnetic Wire Medium for Home Movies." *Home Movies*, Vol. 10, pp. 280–81, 297–98; September

"Recordings on Hair-Like Wire." *Science Digest*, Vol. 14, pp. 94–95; November. Sixty-six minutes of continuous speech can be recorded on 11,500 feet of hairlike steel wire on a spool no larger than the ordinary doughnut, in a new type of wire sound recorder being built by General Electric Co.

Schuster, R. R., *Recorder (AN/ANQ-XA-), and Recorder-Reproducer ANQ-1 (XA-1), tradename "Aerobserver."* (Aircraft Radio Laboratory ARL Engineering Report 333.) Office of Publication Board Report. PB 6232, 21 p. A report on tests made of Recorder and Recorder-Reproducer manufactured by the Heller Magnograph Corporation, Los Angeles, California. These are units using magnetic recording tape for installation in aircraft for recording and reproducing speech. In its present form equipment it is not sufficiently reliable for military use, but could easily be modified, without major redesign, to be useful for many applications, such as recording pilot-student conversation during flight training, recording results of test flights and tactical flights and communication with ground units (by dropping record by parachute). Photographs and graphs.

"Sound through Magnetism." *Fortune*, Vol. 28, pp. 6+; September. A short discussion of the history and manufacturing possibilities of wire recording.

"Voice Recorded on Hair-Like Wire." *General Electric Review*, Vol. 46, p. 694; December. A short item on the Armour Research Foundation wire recorder to be produced by General Electric.

"Wire for Sound; Magnetic Wire Sound Recorder." *Time*, Vol. 41, p. 58; May 17. News item discusses the new portable wire recorder and its Army-Navy approval.

"Wire Recorders for Army." *Electronics*, Vol. 16, p. 234+; October. Describes the army's use of wire recorders for entertainment and reporting purposes.

1944

Aldous, D. W., "Magnetic Recording." *Electrician*, Vol. 133, pp. 138–40; August 18. Distinguishing features of magnetic recording are: recordings of considerable length are possible without interruptions; immediate play-back is possible as no processing is required; recording impressed upon sound carrier can easily be obliterated, thus leaving tape free for further recordings, and it is substantially unaffected by vibration, mechanical shocks or position; new General Electric Model 50 instrument is illustrated. Bibliography.

Allgemeine Elektrizitats Gesellschaft, Berlin. *Magnetic recorder K-4* (Magnetophon K-4) (AEF Report 3: AAF-T-22 Reel 2302, Frame 979) n.d. 27 p. Description of, and operation instructions for sound recording and sound reproduction equipment Magnetophone K-4. Abstract prepared at Headquarters Air Material Command, Wright Field, Dayton, Ohio.

——— *RPF K4 special twin Magnetophone equipment.* PB L 85359. 1944, 23 p. This document covers the description and operation of the Magnetophone, which is a sound recording and playback apparatus using dielectric bands with imbedded magnetizable particles for the recording of sound. Photographs are included (In German).

Ashman, G. L., "Magnetic Recording." *Wireless World*, Vol. 50, pp. 226–28; August. Simple exposition of principles involved. Bibliography.

"B.B.C. Mobile Recording Equipment." *Ibid.*, Vol. 50, pp. 133–35; May. Includes technical details on wire recording.

Blain, R. "Sound Recording." *Telephony*, Vol. 126, pp. 20–21; June 10. Magnetic wire recorder by General Electric Company.

Columbia University. Division of War Research. Airborne Instruments Laboratory. *Handbook of Instruction: Magnetic Tape Recorder.* Serial no. 1, 2, and 3 (Report 1305–9) PB 13887. 64 p. It is the purpose of this handbook to provide sufficient information to enable maintenance personnel to make any electrical or mechanical repairs necessary to keep the magnetic tape recorder in good operating condition. The magnetic tape recorder is described in detail with many illustrative photographs. Installation, adjustments, operation, and maintenance are covered in the handbook. There is a table of replaceable parts and there are a number of diagrams.

——— *Handbook of instructions: Magnetic tape recorder.* Serial no. 4, 5, and 6 (Report 1305–7) PB 13885. 68 p. This handbook describes subject tape recorder and discusses installation operation and maintenance of the unit. There is a table of replaceable parts. Numerous illustrations and diagrams are also included.

Cooke, J. F., "Recording on Wire." *Etude*, Vol. 62, pp. 24+; January.

Corddry, C., "Aerial Eavesdropper; Magnetic Wire Recorder Has Brought Back Records of Air Battles, Has Many Other Uses in Aviation." *Flying*, Vol. 35, pp. 67–68+; August.

Dunlevy, M. H., and Rob, D. E., *Examination and test of preliminary Model of Recorder AN/ANQ-1 (XA-5) and Recorder-Reproducer AN/GNQ-1 (XA-5).* (Aircraft Radio Laboratory ARL Memorandum Report 181). Office of Publication Board Report. PB 6235, 24 p. Tests were conducted on preliminary models of Recorder and Recorder-Reproducer, developed by the Brush Development Company, Cleveland, Ohio, to determine performance and to evaluate the over-all design. Equipment consists of an airborne recorder and a ground playback unit. Recording is done magnetically on a 0.006 inch stainless steel wire. On the whole, equipment meets service requirements and it is recommended that procurement be initiated. Recorder-Reproducer can reproduce the material recorded on the magazine and can, in addition, record, rewind, or erase, in order to prepare the magazine for reuse. Photographs and graphs.

Grahame, A., "Recording the Saipan Fight on Wire." *Popular Science*, Vol. 145, p. 201; December. Wire recording brings first-hand report of the 13-day struggle for Saipan.

Hanson, R. O., *The General Electric Model 20 N Wire Recorder.* (Columbia University Division of War Research Memo P37/R809). PB L 81053. 13 p.; March. At the request of the BuAero, work was done by the New London Laboratory on the General Electric Model 20 N Magnetic Wire Recorder to improve its frequency response. Some nine changes are listed and explained. After all the changes had been made in the machines a testing procedure was applied. This testing procedure is described in this file memorandum. Two photographs, curves, and diagrams are included.

——— *General Electric Model 20 N Wire Recorder.* (Columbia University Division of War Research Memo P37/R909). PB L 81054. 23 p.; May. This report concerns changes made on the 20 N magnetic wire recorder to improve its frequency response and adapt it for use specifically with radio receivers. Schematic drawings showing the unmodified 20A circuit arrangement and for 20N showing modifications, with graph and photographs, are attached.

"Invasion Recorder; Magnetic Wire Recorder, Used by Marines in Producing Permanent Record of Landing Operation on Bougainville." *General Electric Review*, Vol. 47, p. 44; July.

Kaar, I. J., "Talking Wire Finds New Uses." *Science Digest*, Vol. 15, pp. 89–90; February.

Krupp Werke, Friedrich, "Essen. Development of Steel Wire for Sound Recording as Magnetogram Carriers (Isophones), 1940–1941. Frames 1902–1930, 1950–1966. Steel Research." *FIAT Microfilm Reel L 58, Frames 1641–2506. (1936–1944).* PB L 73870 (In German).

——— "Resistance Measurement in Steel Wires for Sound Recording for Electric Current Parallel to and Transverse to the Direction of Force, 1940–1941. Frames 1931–1949, 1967–1969. Steel Research." *FIAT Microfilm Reel L 58, Frames 1641–2506. (1936–1944).* PB L 73870 (In German).

Opperman, R. H., "Record Voice on Hair-Like Wire." *Franklin Institute Journal*, Vol. 237, p. 160; February. News item.

Pugsley, D. C., "Engineering Details of Magnetic Wire Recorder." *Electronic Industries*, Vol. 3, pp. 116–18+; January. Design principles and mechanical construction that have made possible practical perfection of magnetic wire recording machines; illustrations of equipment and complete wiring diagrams of General Electric produced recording and reproducing equipment.

——— "Fundamentals of Magnetic Recording." *QST*, Vol. 28, pp. 10–12; May. The magnetic recorder, although old in principle, in application is essentially a wartime development. In this article, in addition to a discussion of the basic principles involved, the author includes a brief description of a current production-model recorder and play-back unit.

Selby, M. C., "Investigation of Magnetic Tape Recorders." *Electronics*, Vol. 17, pp. 133–35+; May. Performance characteristics and curves obtained for particular application by parameter elimination procedure are presented as being typical of magnetic recorders. Bibliography.

Temple, M. D., and others, *Investigations of New Magnetic Recording Media.* Final report. (Office of Scientific Research and Development Report 3399) PB 33200. 129 p.; February. This report describes investigations to develop improved magnetic materials for use in magnetic recording. Work has been done with both disks and endless tapes. The Case School and the Battelle Institute have served as subcontractors under the Brush Development Co. Different aspects of the problem have been studied by each of the institutions. The Case group has applied the technique of vacuum evaporation of films with no significant improvement. The Battelle Institute has employed the deposition of finely divided magnetic powders to plastic base with results that give some promise of ultimate gain. The Brush Development Co., employing the technique of electroplating, has achieved a definite improvement in the magnetic characteristics of disks using alloys of iron-cobalt and molybdenum. Photographs, graphs, and schematic diagrams are included.

Thiessen, G. J., *The Magnetophone of A.E.G., 150 Hohenzollern Damm, Berlin/Grünewald.* (British Intelligence Objectives Subcommittee Final Report 207, Item 9) n.d. 10 p. This is a report about a tape recording equipment built by A.E.G., and using a plastic tape with a powdered magnetic film on it which is manufactured by I. G. Farbenindustrie. The recording and reproducing devices are described and illustrations appended.

Toomin, Hershel, and Wildfeuer, David, "Mechanism of Supersonic Frequencies as Applied to Magnetic Recording." PROCEEDINGS OF THE IRE, Vol. 32, pp. 664–68; November. Addition of supersonic current to signal current in recording on magnetic medium results in recordings of low harmonic distortion; mechanism whereby this type of recording operates is presented; extension in oscillographic technique of obtaining BH curves of magnetic specimens is presented; circuit is given which makes possible simultaneous viewing of major and minor hysteresis loops.

U. S. Bureau of Aeronautics. Video Recorder. (Navy Department Bureau of Aeronautics Specification EP-224) PB 37825. 6 p.; September. The equipment specified in this paper shall be designed for use with the An/ARR-5 or similar receiver for recording received signals. It shall be used to monitor, record, or reproduce the received signals, and shall be of use in naval aircraft such as PV, PB4Y-2, and other petrol craft. The unit shall operate from the output of the 5.25 mc IF of the receiver; this frequency being converted to 30 kilocycles, at which frequency it is amplified and recorded.

U. S. Army. Report on the Magnetophone (field model). Office of Publication Board Report. PB 1347. 21 p. This report describes German magnetic tape recorders Tonschreiber Models b and b1 and presents instructions for their operation. With the exception of the synchronous speed control system of Model b both models are identical. Data and diagrams presented in this report were obtained by circuit tracing, circuit analysis and tests made by the Enemy Equipment Intelligence Service team. Model b records an audio signal on a magnetic ribbon. Provision has been made for play back and for rewinding and wiping tape used. Electrical components, all of German manufacture, are: capacitors, inductors, resistors, rectifiers, tubes. Experimental tests made with these machines indicate that they are satisfactory for code or voice messages but not successful for the recording of music. A complete list of parts is given. Diagrams and photographs of equipment are included.

Yoder, R. M., "Young Man with a Wire." *Rotarian*, Vol. 64, pp. 14–16; February. Marvin Camras records eight hours of sound on a 5-inch spool.

## 1945

Boyers, J. S., *Notes on the Operation of Wire Recorders at the New London Laboratory.* (Columbia University Division of War Research Memo P37/R1330) PB L 80604. 26 p. February. These notes on the operation of the wire recorder refer particularly to the prevention of irregularities in the recording and reproducing opera-

tion and the treatment and care to be given to the reproducing wire and the mechanics of the recorder in general. The advantages of the Model 20 Recorder over Model 50 are described. Photographs and drawings included.

Brooker, V. M., "Some Aspects of Sound Recording." *Institution of Radio Engineers (Australia) Proceedings*, Vol. 6, pp. 3–9; September.

Brush Development Co., Cleveland (Kornei, O., and others). *Investigations of New Magnetic Recording Media.* Final report. (Office of Scientific Research and Development Report 5325; National Defense Research Committee Report 17.1–92) PB 24881. 103 p.; June. This report is a final summary of the work done by the Brush Development Company and the Battelle Memorial Institute on the development of improved media for magnetic recording. Two different types of tape have been developed and are described. One consists of a cobalt-nickel electroplating on a phosphor-bronze strip, and the second consists of a thin layer of magnetite, laid with a satisfactory binding medium on a paper or plastic tape. The appendix contains a description of a recording reproducing head, of how the magnetic measurements of the investigated recording media were obtained, and of the test equipment used. Photographs, circuit diagram, tables and graphs are included.

Carlisle, Gerald. *Technical Report on the German Tape Recorder, Schnellmorsebildschreiber* (S. MbS.) (Enemy Equipment Intelligence Service Signal Section, European Theater Report 9–20) PB 27762. 7 p.; July. This report presents general information, tactical characteristics, technical data, and operation instructions for subject set, which is a standard piece of equipment and not an experimental model. Circuit diagrams and photographs are included. It is a field pack set and records code sent at a speed up to 200 wpm. Parts of this report will not reproduce well.

Debell, John and others. Military Planning Division, Office of the Quartermaster General. *German Plastics Practices.* (GMC Overseas Investigation Team Report.) Office of Publication Board Report. PB 12467. 374 p.

"Electronic Dictation." *Purchasing*, Vol. 19, pp. 116–117+; December. Illustrated description of Armour Magnetic Sound Recorder and Reproducer, developed by Armour Research Foundation; sound is magnetically recorded on thread of wire as it is reeled from one spool to another; rewinding of wire reproduces recording; process is matter of spool placement, adjusting wire through recording head, and turning on electric power; standard spools hold 11,500 feet of wire which provides for 66 minutes of recording time at wire speed of 2½ feet per second.

"Electronic Principles for Steel Wire Recorder." *Electrical News and Engineering*, Vol. 54, pp. 49–51; May 1.

Farr, R. N., "Sound on the Record." *Science News Letter*, Vol. 47, pp. 362–64+; June 9. Describes new and improved methods, developed in recent years, which will mean better recordings for longer periods of time and at lower cost.

"German Magnetic Tape Machine Brought to U. S." *Ibid.*, Vol. 48, p. 399; December 22. News item.

"German Magnetic-Tape Recorder." *Electronics*, Vol. 18, pp. 402–403; November. News item.

"German's Tape Recorder, Magnetophon, is Termed Superior to Other Methods." *Broadcasting*, p. 24; September 3. News item.

Hansell, C. W., *Miscellaneous Developments in German Sciences and Industry.* Report C-60. (Joint Intelligence Objectives Agency Report 68) PB 31594. 36 p. June. This is a compilation of reports on various developments in German science and industry, originally issued through the Technical Industry Intelligence Committee. Includes a brief description of magnetophone sound recorder.

——— *Report on the Magnetophone.* Office of Publication Board Report. PB 1346. 13 p. Allgemeine Elektrische Gesellschaft (A.E.G.) and I. G. Farben cooperated in developing a plastic tape type of magnetic sound record and a machine to utilize it in recording and reproducing sound. Equipment manufactured at A.E.G. and tapes produced at Farben Ludwigshafen plant were sold by Magnetophone Inc., Berlin. This development was so successful that tapes and equipment were used quite generally throughout the German radio broadcasting system and for many military and industrial purposes. Part I of this report written by C. W. Hansell, describes the Magnetophone. Recordings and reproduction made with this equipment were excellent and had very low noise level. Part II describes the various types of tape, their properties and chemical specifications, and their method of manufacture.

Hanson, R. O., *The BTL High Fidelity Tape Recorder.* (Columbia University Division of War Research Memo P37/R1320). PB L 80603. 37 p.; January. This report contains a detailed description and operating instructions of the Bell Telephone Laboratories (five minute) High Fidelity Tape Recorder used by the Sound Recording Group of the U. S. Navy Underwater Sound Laboratory at New London. Photographs, drawings, and diagrams included.

——— and Boyers, J. S., *Two Second Tape Loop Recorder—Reproducer Set.* (Columbia University Division of War Research Memo P37/R1334). 56 p.; February. The two-second magnetic tape loop recorder-reproducer set is a unit which will record and reproduce a sample of sound of two seconds duration. A valuable feature of this type recording is that the material recorded may be reproduced a great number of times without deterioration. Automatic electronic features are included which make it possible to record a complete tape without overlap or serious disturbance at the point of switching. The loop recording machine is housed in a separate case and has a frequency range of 50 to 25,000 cps. Instructions for the operation and maintenance of the unit are included in this memorandum together with several photographs, tables and graphs pertaining to the equipment.

Henderson, R. G., *Translation of Operating Instructions.* Tonschreiber model b. Office of Publication Board Report. PB 1028. The equipment is designed primarily for connection to a radio receiver, and it is magnetically operated, using a magnetic tape. The tone voltage fed from the receiver output to the recorder input magnetizes the tape as it runs past the magnetic reproducing head either during the recording process or after winding back. Sensitized film on which the signals are no longer required can be demagnetized and used again. With the recorder switched to "record" demagnetization is automatic. A ribbon speed of 18 cm/sec. is sufficient for telegraphy up to 200 signals per minute, but a higher speed (approximately 72 cm/sec) is desirable for high speed telegraphy or telephony. The report supplements Report, PB 1027 "German magnetic tape records. Tonschreiber models b and b1."

Holmes, L. C., "High Quality Sound Recording on Magnetic Wire." *Communications*, Vol. 25, pp. 44, 46; December. Reports on several high-quality wire-recording processes that have been evolved by Stromberg-Carlson.

——— "High Quality Sound Recording on Magnetic Wire." *Electronic Industries*, Vol. 4, p. 77; December. News item on a flexible laboratory recorder demonstrated at the New York section of the IRE.

——— and Clark, D. L., "Supersonic Bias for Magnetic Recording." *Electronics*, Vol. 18, pp. 126–36; July. Measurements of factors governing noise level, linearity, and frequency response; measurements indicate effects of recording reproducing head design and wire speed on frequency response. Bibliography.

"It Pays to Listen." *Scientific American*, Vol. 173, pp. 18–20; July. Wire-recording equipment and other electronic instruments are giving new ears to factory men. New accuracies in machine and process industries made possible by studying and comparing noises, are speeding production, improving quality, and cutting costs.

Kern, J. G. and others, *I. G. Farbenindustrie A. G., Ludwigshafen and Oppau Wehrmacht items.* Office of Publication Board Report. PB 385. 69 p. Detailed report on processes and equipment in the manufacture of items for the Wehrmacht and in research undertaken for them at these two plants.

"Magnetic Wire Recorder." *Electronics*, Vol. 18, p. 386; February News item about availability of Model 51, General Electric Co.

"Magnetic Wire Sound Recorder and Reproducer." *Electronics*, Vol. 18, pp. 360+; June; *Architectural Forum*, Vol. 82, pp. 190+; June. A description of Model 50 Armour wire recorder for both recording and reproducing.

Manchester, H., "Wire that Talks and Sings." *Reader's Digest*, Vol. 47, pp. 37–39; August. A new kind of sound recording brings fascinating possibilities for entertainment and convenience.

Miller, A. E., "Consumer Interviews by Mechanical Recording." *Printers Ink*, Vol. 213, pp. 122+; October 5. Marketing research possibilities through use of a portable field set wire recorder.

Nichols, W. C., and Palma, J., "Proposed Designs for Wire Recorders." *Modern Plastics*, Vol. 22, pp. 103–05; July. Description of Armour magnetic wire sound recorder and reproducer, which records sound magnetically on spool of wire nearly as fine as human hair; then, as soon as wire has been rewound, recording can be played back with high fidelity; proposed designs which suggest few of many

possible postwar applications for this wire recorder are set forth; use of plastics in manufacture of recorders.

Pflaumer, "Entwicklung und Fabrikation der Magnetophon-Bander" ("Development and Manufacture of Tapes for Magnetic Recorders"). PB 97131. 23 p.; October (Text in German).

"Pocket Model Wire Recorder." *Popular Mechanics*, Vol. 84, p. 144; July. A tiny portable wire recorder for emergency and "spot" recording measures 7¾ by 4 by 1¾ inches and weighs 3 pounds.

Raynor, K. C., *German Magnetic Tape Recorders*. Tonschreiber mocels b and b1. Office of Publication Board Report. PB 1027. 24 p. This report covers German magnetic tape recorders, Tonschreiber models b and b1. The Tonschreiber b was manufactured in 1942 while the b1 was made in 1943. However, with the exception of the synchronous speed control system, both models are identical. The equipment offers the facility of recording an audio signal on a magnetic ribbon. During the recording process, the quality and level of the signal impressed on the tape may be monitored. Provision has also been made for playback and for rewinding and wiping the tape used. Publication gives operating instructions and lists parts, giving markings, size, resistance, voltage ratings, capacity, description, and types. Wiring diagrams and photographs are also given. Translation of operating instruction of Tonschrieber model b is given in Report 1028.

"Recorders Coming; Device Using Wire." *Business Week*, pp. 54–56; December 29. News item.

Rose, C. E., and White, D. R., *Report on Interviews with Technical Personnel from the Agfa Plant at Wolfen*. Office of Publication Board Report. PB 1312. 45 p. This report presents information obtained from personnel of Agfa plant, Wolfen, on film base casting, emulsion manufacture and coating and finishing processes. A general summary is given on these subjects, followed by reports of information obtained from individual interviews. Appendices contain supplementary and additional material in German and includes an article by Prof. Eggert and Dr. Lübeck entitled "Das Magnetophonverfahren."

Shaper, H. B., "Frequency-Modulated Magnetic-Tape Transient Recorder." PROCEEDINGS OF THE IRE, Vol. 33, pp. 753–60; November. A transient recorder having a frequency range of 0.02 to 1.000 cps with useful response up to 2000 cps is discussed. The transient is recorded on a loop of magnetic tape and played back synchronously every 0.1 second on an oscilloscope screen. Thus, a steady image of the transient is obtained. Excellent signal-to-noise ratio (40 db) is obtained by the use of a 10 kc carrier, which is frequency modulated. Each recording can be obliterated by simply pressing a button, with no material being consumed. A set of typical oscillograms is given.

"Sound Business; Makers of Wire Recorders Will Discuss Standardization." *Business Week*, p. 22; March 31. News item.

Tinkham, R. J., "Multiple Wire Recording." *Communications*, Vol. 25, p. 99; December. The prospect of widespread public acceptance makes it desirable to provide means for making duplicate wire records in quantity and at low cost. A progress report news item.

U. S. Army Signal Corps, *German Tape Impulse Recorder*. (Captured Enemy Communication Equipment Report. Enemy Equipment Intelligence Service-8-25) Office of Publication Board Report. PB 2259. 7 p. Description of a captured German instrument used at an automatic telephone exchange or subscriber phone to check the uniformity and characteristics of the dial impulse. The tactical and technical characteristics of the recorder are listed, and pictures and a wiring diagram are given.

——— *Magnetic Sound Recorders "Magnetophone" and "Tonschreiber."* (Intelligence Report, SRM-1) Office of Publication Board Report. PB 3586. 54 p. This report describes the "Magnetophone" and "Tonschreiber" German sound recorders. In principle the same, several models of each provide recording facilities for any purpose from code recording in front lines to extremely high quality installations in broadcasting stations. Details of the mechanism, electrical circuits, and the magnetic tape employed for the records are set forth. Contains diagrams and photographs.

——— *Spot Report on German* MS 2 (*Code Tape Recorder*). Office of Publication Board Report. PB 2243. 7 p. Description and photographs of this apparatus are given. The instrument has no unusual features and is fairly well designed.

——— *Technical Data, Reports and Specifications Covering Vacuum Tubes (Telefunken and Philips) Frequency Meters, Voltage Dividers, Magnetic Field Recorders, etc.* 1940–1945. PB 84905. 1479 p. (Text in German).

U. S. Army Air Forces. *Handbook of Maintenance Instruction for Recorder AN/ANQ-1A*. (Tech Order AN 16-30ANQ1-2) PB 55931. 36 p.; June.

——— *Handbook of Operating Instruction for Recorder AN/ANQ-1A*. (Tech Order AN 16-30ANQ1-3) PB 55932. 14 p.; May.

U. S. (Holabird Signal Depot), *German Magnetic Tape Recorder*. (Tonschreiber b and b1) (Captured Enemy Equipment Report T-19) PB 33126. 22 p.; December. The Tonschreiber b is a recording device that operates on the same principle as American steel wire and tape recorders, but, instead of using wire or tape, it uses a coated cellulose tape for the recording medium. Also, in contrast to general American practice, it uses dc bias on the tape. Any tape speed from 9 to 120 cm/sec may be used for either recording or playback, thus providing maximum economy of tape for all type of recording. Any desired speed is easily selected and, once selected, the stability is good. The reels of tape which normally come with the set hold enough tape for approximately one hour of operation at 72 cm/sec. Listening tests and curves made on the frequency response of the set show that it is satisfactory for any type of code or voice message but could not be considered "high fidelity" for the reproduction of music. At the higher tape speeds the high frequency response is good, but the bass response is poor at all tape speeds, falling off rapidly below 1,000 cycles or higher. Operating instructions are presented. Graphs and schematic diagrams are included.

U. S. War Department, *Magnetic Wire Recorder* (G-E model 20B-2). (Tech. Manual 11-2576) PB 48394. 18 p.; February. The subject equipment is a portable wire-recording device designed for operation on a nominal 28 volt dc power source consisting of 24 BA35 dry cells. The unit functions primarily as a recording device but it may also serve as a two-station interphone system. The recorder unit is composed of a recording mechanism, an audio amplifier, a 30 kc oscillator, a driving motor, and accessories consisting of two microphones, recording wire, spools, and tools. Two types 28D7 tubes are employed as a push-pull amplifier and oscillator. Photographs and drawings are included.

——— *Magnetic Wire Recorder* (G-E model 20N-1). (With supplement April 2, 1945.) (Tech. Manual 11-2544) PB 48304. 21 p.; February. Model 20N-1 recorder is a wire-recording device designed for operating on a nominal 28-volt dc power source. The unit functions primarily as a recording device but it may also serve as a two-station interphone system. The unit is composed of a recording mechanism, an audio amplifier, a 30 kc oscillator, a driving motor, and accessories. The description, explanation of the functions, and instructions for the installation and maintenance are given in this manual. Photographs, drawings, diagram, and a list of parts are included.

——— *Magnetic Wire Recorder*. (G-E models 50A and 51) (Technical Manual 11-2548) PB 37072. 26 p.; February. The equipment described in this manual is a portable wire recording device capable of making permanent recordings on steel wire and playing them back immediately. The machine simultaneously erases a previous recording while a new recording is made. The recorder and reproducer consists of a full wave rectifier, a three state audio amplifier, a 30 kc oscillator, a recording mechanism, 4 drive motor and associated mechanism, and accessories. The output of the 30 kc oscillator is used to erase previous recording and to prevent amplitude distortion, by superposition on the recording wire. The two models described here are practically identical except for minor arrangements in the tone-compensation circuit and the output circuit. Both models are designed for 115 volt ac, 60 cycle operation. A complete description of the equipment and installation and operating instructions are given. Photographs, schematics, and maintenance data are included.

Winter, C. E., "Magnetic Tape Recording." *Radio News*, Vol. 55, pp. 32–34+; June. Résumé of the development of magnetic tape recording and a description of a modern recorder of this type.

"Wire Dictating Machine." *Business Week*, p. 58+; September 22. News item.

"Wire Sound Recorder." *Modern Metals*, Vol. 1, pp. 16–17; July; *Electrical News and Engineering*, Vol. 54, pp. 49–51; May 1. Description of magnetic wire sound recorder developed at Armour Research Foundation; application of aluminum in its design and construction discussed in relation to postwar uses, influenced by its light weight and consequent easy carrying capabilities.

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Allgemeine Elektrizitats Gesellschaft, Berlin and Kiel. *Magnetophone*

*Sound Recorder and Reproducer, 1939–1946.* Office of Publication Board Report. PB 95210. 711 f. (Text in German and English).
——— ——— Office of Publication Board Report. PB 95211. 756 f. (Text in German and English.)

Begun, S. J., "Magnetic Recording (Summary)." *Communications*, Vol. 26, pp. 31, 33; April. Highlights of discussion by Dr. S. J. Begun on magnetic recording before the Sixth Annual Conference of Broadcast Engineers.

Camras, Marvin, "Theoretical Response from Magnetic-Wire Record." PROCEEDINGS OF THE IRE, Vol. 34, pp. 597–602; August. Effect of magnetic properties of record wire on output level and frequency response of magnetic recording system; amount of magnetic energy that can be stored at each wavelength determines voltage output to be expected from given translating head; frequency response for typical record wire is calculated according to derived relations, and compared with experimental data.

"Continuous Wire Record; Plays back Display Message Without Rewind." *Scientific American*, Vol. 175, p. 131; September. Use of wire recorder for window or showroom displays, for voice tests, and as a device to attract audiences to booths and sales conventions or public displays, has now been developed.

Crawford, J. W. C. and others, *Plastics in German Sound Recording Systems.* (British Intelligence Objectives Subcommittee Final Report 1379, Item 7, 22). PB L 87901. 121 p.; April–May. This report is concerned less with the electro-chemical side of the process and more with aspects of interest to the plastics technologist. The following points are covered: discussion of Magnetophone, coating of luvitherm to produce Magnetophone tape I.G; Magnetophone band type C and L; production of gammaferric oxide; production of vinoflex MP 400; discussion of luvitherm and allied subjects at Ludwigshafen; luvitherm manufacture at I. G. Gendorf, and Folienfabrik Fürth-Forchheim; luvitherm production by Dynamit A. G. Troisdorf; luvitherm calenders by Hermann Berstorff G.m.b.H.; luvitherm machinery by Erwin Kampf. Bielstein-Mühlen; production of gramophone records by Deutsche Grammophon, Hannover; manufacture of Fullstoff K3, Degussa, Cologne; and Tefi recording and reproducing system. Tefi G.m.b.H. photographs and drawings are attached.

Crittenden, E. C. and others, "B.H. Meter for Samples of Small Cross-Sectional Area." *Review of Scientific Instruments*, Vol. 17, pp. 372–374; October. Describes principles employed by the Brush Development Company to produce a commercial instrument which they have used in testing and production control of magnetic recording.

"Engineering Features of Recording Equipment." *Electronic Industries*, Vol. 5, pp. 70–71; March. Brief descriptions of magnetic and other home recording devices for applications such as transcription of radio program material, exhibited and discussed at IRE Winter Technical Meeting, N. Y., January 23–26, 1946; Brush Laboratories magnetically coated paper tape recorder; German built magnetic tape recorder; Brush Laboratories wire recorder; Recordograph embossed film; Armour Research Foundation system using 0.004 inch diameter stainless steel wire.

Franklin Institute (Bartol Research Foundation), *Some Theoretical Considerations Concerning Magnetic Sound Recording.* PB 98854. 76 p. An attempt is made to treat theoretically the various factors which determine the properties of a magnetic sound recording, in order to provide understanding of experimental results. The problems dealt with include those of the effect of demagnetization and the relative importance of the factors determining frequency responsibility. The results demonstrate the great importance of the demagnetization function and postulate more effort toward improving recording and playback heads.

*"German Magnetic Recorders." The Magnetophone K.7. British Broadcasting Corp. Research Dept. Report* no. C.053/3; October, 1946.

"German Tape-Recording Equipment." *Electronic Engineering*, Vol. 18, p. 54; February. Summary of recent report of U. S. Broadcasting Commission in Europe, on German developed recording and playback equipment; tape used is form of dry processed unplasticized polyvinyl chloride 0.035 mm thick, on which is coated layer of black iron oxide mixture 0.008 to 0.01 mm thick; small magnetic amature is used to produce recording. From abstract of Commission's report in *Electronic Industries*, November, 1945.

Harcourt, W. M., *Agfa Colour.* (British Intelligence Objectives Subcommittee Final Report 397, Item 9) PB 25659. 20 p.; January. This report consists of three reports on the Agfa color developments in Germany. Also included is a report of a conversation with Bruno Jensens, ex-chief sound engineer of UFA studios, who told of the new playback machine which employs an ironized tape. The advantages of these machines are that the ribbon can be cut and edited and joined similarly to any other film and may be played back, without any background noise, eight or nine hundred times.

Holman, R. L., "Sound Trapped by Wire." *American Mercury*, Vol. 62, pp. 654–57; June.

Holmes, L. C. "High Quality Sound Recording on Magnetic Wire." *Electronics*, Vol. 19, pp. 236, 238, 240; January. Abstract of paper presented at the New York section, fall IRE meeting in Rochester.

"Industrial Research Progress at Armour Research Foundation, 1944–1945." *Chemical and Engineering News*, Vol. 24, pp. 161–172; January 25. Reference is made to "wire recording" activity on pp. 167, 170.

Javitz, A. E., "Appraisal of Design Trends in Magnetic Sound Recorders." *Electrical Manufacturing*, Vol. 37, pp. 107–11+; June. Wire and magnetic tape recorders are being prepared for varied civilian uses; improved record-reproduce-erase heads, new recording media, and simplified drives are features.

Long, T. H., and McMullen, G. D., "B-H Curve Tracer for Magnetic-Recording Wire." *American Institute of Electrical Engineers Transaction*, Vol. 65, pp. 146–149; March. Equipment described is able to show on screen of oscilloscope, cyclic hysteresis loop of sample of magnetic-recording wire little over 1 inch long and 0.004 inch in diameter; results obtained with equipment in studying recording wires are given; discussion is included of operation of equipment and of possible modifications.

——— ———. *Ibid.*, Vol. 54, p. 494. Discussion and author's closure of paper published in March, 1946 issue of *Transactions.*

Long, T. H., "New Wire Recorder Head Design." *Ibid.*, Vol. 65, pp. 216–20; April. Certain defects inherent in usual design of wire recorder heads are pointed out; some defects are of practical nature and one is based on theoretical considerations; improved design is proposed on which limited amount of experience has been obtained; natural modification of this permits level winding across record playback head, thus distributing wear and resulting in head that is virtually self-cleaning.

——— ———. *Ibid.*, Vol. 65, pp. 495–97. Discussion and author's closure of paper published in April, 1946 issue of *Transactions.*

"Magnetic Wire Recorder Tensioning Mechanism." *Product Engineering*, Vol. 17, p. 372; May. Portable model magnetic wire recording machine, for home and office use, has been developed by the Brush Development Company. Size is approximately 14 inches by 11 inches by 8 inches deep and weight is less than 30 pounds. Device consists of three essential elements: the recording head, the recording wire, and the tensioning mechanism. Recording wire is a ductile wire electroplated with a magnetic material. Tensioning mechanism is an ingenious differential device developed by A. L. Williams, president of the company.

*The "Magnetophon" of A.E.G. 150 Hohenzollern Damm. Berlin/Brunewald.* (British Intelligence Objectives Subcommittee Report no. 207) H.M.S.O.; U. S. Dept. of Commerce. 4 p. A band of cellulose acetate, covered with a thin film of powdered magnetite, runs tangentially past a narrow gap in a toroidal magnet. The magnet is made of high permeability laminated material and has a second wider gap diametrically opposite the first, which has the effect of decreasing the residual magnetism due to large current pulses. The tape speed is 77 cm/sec and the tape runs in succession past an ac wiper, for demagnetization, recording head, and pick-up head. The reproducing amplifier has transformer input with a turns ratio of 1:62.5, the secondary having a load of 500,000 Ω to keep down the response at hf. The circuit includes various frequency compensators of conventional type. Fidelity of reproduction could not be judged properly, since only a poor loudspeaker was available, but fidelity was found to be much better than with a wire recorder.

*The Magnetophon Sound Recording and Reproducing System.* (British Intelligence Objectives Subcommittee Report no. 951) H.M.S.O.; U. S. Dept. of Commerce. 34 p. A more extensive account of B.I.O.S. Report no. 207. Illustrations and descriptions of various types and details of the manufacture of the special tape employed.

Menard, J. Z., *High Frequency Magnetophon Magnetic Sound Recorders.* (Field Information Agency Technical. Final Report 705), PB 12659. 44 p. This report gives details of the high frequency models of the German Magnetophon magnetic sound recorders. A detailed discussion of the recording system is given, with considerable research and design information pertaining to the mechanical system, electrical circuits, recording processes, and the

tape used for recording. Schematic and performance curves of some systems are included. (JZM). The Magnetophon recorders were developed by the Reichsrundfunk Gesellschaft (German State Broadcasting Service) using plastic tape impregnated with microscopic particles of magnetic materials, and high frequency recording and erasing of the recordings, and found applications in most of the broadcasting stations replacing to advantage other types.

Power, R. A., "German Magnetophon." *Wireless World*, Vol. 52, pp. 195–98; June. A.E.G. Co. Magnetophon high quality tape recording and reproducing machines are described; latest model employs magnetite impregnated plastic tape, and supersonic system of recording and erasing which features better signal to noise ratio than former system; tapes retain magnetic qualities indefinitely and are not subject to aging; advantages over wire recorders are listed.

Pugsley, C. W., "Wire Recording." *Electrical Engineering*, Vol. 65, 316–21; July. Magnetic wire recording, which has been known since 1896, found many applications during World War II where Armed Forces needed light weight portable recording equipment which could operate under wide variety of conditions; although this method of recording had disadvantages in comparison with other more highly developed types employed today, promising future is indicated.

Pulling, M. J. L., *The Magnetophon Sound Recording and Reproducing System.* (British Intelligence Objectives Subcommittee Final Report 951, Item 7, 9). PB L 60899. 113 p. This volume contains a full description of the Magnetophon, a magnetic tape recording and reproducing device developed during the war years in Germany to a considerable degree of efficiency. Various types of Magnetophon and their specific military and civilian applications are discussed and comparisons made to similar equipment developed elsewhere. Manufacturing methods of the recording tape and its composition are given. The report includes English translations of articles on the Magnetophon written in German by men who had worked on its development. Photographs, graphs, and circuit diagrams included.

Randall, C., "Magnetic Sound on Film (8 mm, 16 mm, and 35 mm)." *Home Movies*, Vol. 13, pp. 748, 772–773; December.

Rosenstein, A. B., "Principles and Methods of Magnetic Recording." *Radio News* (*Radio-Electronic Engineering Edition*), Vol. 7, pp. 3–6, 29–30; December. Whether utilizing wire, steel tape, or paper tape, magnetic recording has advantages over other recording media in specific applications.

"Sound Inscribed on Paper Tape; Brush Magnetic Recorders." *Business Week*, p. 50+; January 26. Brush unveils magnetic recorder for home use; also offers a new plated wire which costs less than stainless steel strand hitherto used. All manufacturers in field see big potential for their products.

"Sound on Paper Made Possible by New Magnetic Coating." *Scientific American*, Vol. 174, p. 156; April. News item.

Vaile, R. B., "Recent Developments in Magnetic Recording of Sound." *National Electronics Conference Proceedings*, Vol. 2, pp. 597–602. In moving toward an ideal magnetic recorder, a number of serious problems arise. These problems have to do with 1) the resolution of the recording head, 2) distortion due to nonlinearity of the magnetization curve of the medium and to other properties of it, 3) constant speed drive, 4) permanence of the record, and 5) the transfer of the record from one part of the medium to an adjacent part. The compromises which seem preferable in the present evaluation of solutions to these problems involve the use of 1) longitudinal magnetization of the medium, 2) speed between 0.5 and 5.0 feet per second, and 3) supersonic "bias." In addition there has been extensive work on the development of special materials, new test equipment, and original test methods.

"Wire Recording; Armour Magnetic-Wire Sound Recorder and Reproducer." Abstract. *Mechanical Engineering*, Vol. 68, pp. 357–58; March.

Wooldridge, D. E., "Signal and Noise Levels in Magnetic Tape Recording." *American Institute of Electrical Engineers Transactions*, Vol. 65, pp. 343–52; June. Determination of properties of tape and associated magnetic elements responsible for noise and signal output levels of magnetic recordings; equations give pertinent relationships connecting noise and signal levels with physical properties of tape and pole-pieces; method for decreasing noise and increasing useful signal reproduced from magnetic tape.

——— ———, *Ibid.*, Vol. 65, p. 495. Discussions and author's closure of paper published in June, 1946 issue of *Transactions*.

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Abrams, E. R., "Makers of Wire Recorders Gird for Price Battle." *Barron's*, Vol. 27, p. 10; April 28. News item.

Begun, S. J., "Design Problems on Magnetic Recording Equipment." *Acoustical Society of America Journal*, Vol. 19, p. 289; January. The development of powder coated material as recording media had a profund influence upon the design of magnetic recording equipment. The principal features of a magnetic recorder which uses ¼ inch coated paper tape as a recording medium are described. Even though the recording speed of the paper tape is only 7.5 inches per second, the instrument will handle frequencies up to 5,000 cps. Since the thickness of the recording medium is less than 0.0022 inch, and its motion is slow, approximately half an hour of recording can be accommodated on a standard 8 mm motion picture reel with a diameter of 7 inches. A voice recorder will be described which uses a coated paper disk as a recording medium. The sound track is helically recorded, 40 lines per inch, from an inner diameter of slightly more than 5 inches to an outer diameter of approximately 9 inches. A novel design of a wire recorder is briefly described. This device, has, for a recording medium, a nonmagnetic wire plated with a cobalt-nickel alloy.

Boyers, J. A., and Zenner, R. C., "Master Wire Recorder." *Acoustical Society of America Journal*, Vol. 19, p. 289; January. In the preparation of commercial recordings, the live performance is usually recorded by the use of equipment of the highest possible quality, so that the duplicates made from the master record may still be satisfactory quality despite the losses which are inevitable in any duplication process. A wire recorder has been constructed for use as a master recorder. Design of the unit is discussed, including 1) mechanical drive system, 2) electronic circuits, and 3) properties of the recording wire and heads.

Camras, Marvin. "Magnetic Sound for Motion Pictures." *Society of Motion Picture Engineers Journal*, Vol. 48, pp. 14–28; January. A magnetic sound track on motion picture film is convenient and economical. The final recording can be monitored while it is being made and requires no processing. All or part of the sound track can be erased, and a new record put on; or the film can be edited in the usual manner. Apparatus for making high-quality records is described, including the sound head, constant speed drive mechanism, amplifier equipment, and the magnetic track. Over-all performance, frequency response, dynamic range, and distortion are given. Bibliography.

——— "Magnetic Sound for 8-mm Projection." *Ibid.*, Vol. 48, pp. 348–356; October. A magnetic track deposited between the sprocket holes and the edge of 8-mm film gives good quality sound which can be added to any ordinary 8-mm film. Modifications of standard projectors for using this system are described. Performance for speeds of 16, 18, and 24 frames per second are given.

——— "Recent Developments in Magnetic Recording for Motion Picture Film." *Acoustical Society of America Journal*, Vol. 19, pp. 322–325; March. Magnetic recording gives an ideal sound system for use in motion picture work. Equipment for making the record is light, simple, and inexpensive. The material can be edited by "cutting," or by erasing a re-recording. Sound can also be added after the pictures are complete. Conventional projectors are used with the magnetic system. Response comparable to optical recording is obtained with low distortion and noise. Recording heads, circuits, and mechanical drives for use with various systems are described.

——— ———, *Ibid.*, Vol. 19, p. 389; January.

Chase, Herbert, "Designing Wire Recorder Unit for Low-Cost Quantity Production." *Electrical Manufacturing*, Vol. 39, pp. 122–25+; January. Use of eddy current clutches features effective drive system of new precision, low cost unit manufactured by WIRecorder Corp., Detroit, largely from die cast, stamped, screw machine and sintered powder components; entire unit is only 8 inches wide, 7 inches high and 7 inches deep; with spools and wire it weighs 9 pounds.

Chinn, Howard A., "Magnetic Tape Recorders in Broadcasting." *Audio Engineering*, Vol. 31, pp. 7–10; May. The value of magnetic recorders in broadcasting is not generally appreciated. In this article, the author describes many of the more useful applications of this equipment in this type of service.

——— "Magnetic Tape Recorders in Broadcasting." *Electronic Engineering*, Vol. 19, pp. 393–95; December. Article cites Brush BK 401 Soundmirro equipment as example of modern magnetic recorder and discusses merits and limitations of such devices for radio

broadcast applications; it is held that considerable design and development work will be required to achieve all objectives desirable in "ultimate" magnetic tape recorder. From *Audio Engineering.*

Clark, D. L., and Merrill, L. L., "Field Measurements on Magnetic Recording Heads." PROCEEDINGS OF THE IRE, Vol. 35, pp. 1575–79; December. Method is described for measuring relative values of magnetizing force along path traversed by recording medium in passing through magnetic recording or reproducing head; field distribution curves obtained by this method are shown; method for calculating frequency response of reproducing head from field distribution data.

Clears, G. T., "Magnetic Recording, Reproduction Data." *International Projectionist*, Vol. 22, p. 14; February. The recent flood of data about magnetic recording presented before engineering societies and published in the technical press, notably I.P., indicates clearly that this novel recording and reproducing process is ready to play an important role in the entertainment field, both for 35-mm and lesser gauge films. The appended notes were prepared especially for I.P. by the laboratory in which was done much original research work on this system.

Curtis, J. A., "Passenger Entertainment Systems for Railroad Use." *Tele-Tech*, Vol. 6, pp. 34–37, 96, 97; July. Four channel equipment giving automatic level control feeds any or all cars with radio or wire recorder programs and train announcements.

"Developments in Field of Recording and Mechanical Reproduction; Soundmirror Magnetic Ribbon Recorder-Reproducer and Hyflux." *Musician*, Vol. 52, p. 19; April.

Drenner, D. V. R., "The Magnetophone." *Audio Engineering*, Vol. 31, pp. 7–11, 35; October. This is the first complete discussion of the studio model R22A Magnetophone which has greatly influenced the design of tape recorders in this country.

Engineering Research Associates, Inc., St. Paul, Minn. *Magnetic Recording of Pulses for the Storage of Digital Information.* PB 99668. 53 p.; June. A number of magnetic recording tapes were tested for their pulse-recording characteristics under conditions such that the recording and reproducing heads were not in contact with the surface of the tape. The tapes were cemented to a drum whose peripheral speed ranged from 125 to 1,570 inches per second. A satisfactory head which can be used for recording, reproducing, and erasing operations was developed for work at pulse rates up to 20,000 or more per second. The number of ampere-turns, with which this head should be energized to erase and record on each tape to give maximum signal amplitude, was determined. The character and amplitude of the background signal of dc erased tapes are discussed. Also the effects of changing the tape velocity, head displacement, pulse duration, and pulse repetition rate on the signal amplitude and resolution between successive reproduced signals are described.

——— *Storage of Numbers on Magnetic Tapes.* Summary report. PB 99667. 16 p.; June. The use of magnetic tape for storing numbers in computing machines possesses advantages over other systems when the numbers must be changed frequently or scanned a large number of times. A relatively simple device is described which permits repetitious observance of a series of numbers with or without altering their value or arrangement.

Gellatt, R., "Magnetic Recording, Musical Potentialities of a New Development." *Musical Digest*, pp. 12–13, 29; June.

Gerhard, H. R., "Candid Wire Recordings Put New Life into IGA Dealer Meeting." *Sales Management*, Vol. 59, pp. 118+; August 15. Presents idea for dramatizing retail meetings designed to spread management know-how.

Gorman, Robert, "Storing Sounds on Spool." *Popular Science*, Vol. 150, pp. 144–148; April. Describes the background, development, and future of wire recording.

Haynes, N. M., "Bibliography of Magnetic Recording." *Audio Engineering*, Vol. 31, pp. 30–31, 44–45; October. A chronological list of American and foreign articles on the subject.

——— "The Case for Magnetic Recording." *Radio and Appliance Journal*, p. 25; November.

*High Frequency Magnetophon Magnetic Sound Recorders.* (Field Information Agency Technical no. 705) H.M.S.O.; U. S. Dept. of Commerce, 23 p.; 1947. Two further developments (the stereomagnetophon and a small portable recorder) for the recorder described in B.I.O.S. reports nos. 207 and 951.

Hobson, P. T., "Developments in Magnetic Recording." *Electronic Engineering*, Vol. 19, pp. 377–82; December. Author deals with some British advances in magnetic recording on wire, which have made use of type of recording and playback heads, employed in Armour recorder; analysis of magnetic behavior of wire; use of supersonic bias, operation of recording and playback heads. From lecture before British Sound Recording Association.

——— "Wire Recording." *Electrician*, Vol. 138, pp. 935–36 April 11. A review of recent developments and applications.

Holmes, L. C., "Some Factors Influencing the Choice of a Medium for Magnetic Recording." *Acoustical Society of America Journal*, Vol. 19, p. 288; January. No other single factor contributes so much to the ultimate performance of a magnetic recording system as the recording medium itself. Within the last three or four years, many papers have described the performance of magnetic recording systems but none has given much attention to the correlation between the magnetic properties of the recording medium and the performance of the system. It is the purpose of this paper to show how some of the performance characteristics of magnetic recording system depend on the magnetic characteristics of the recording medium. The most important single magnetic characteristic of the medium for good high frequency response is high coercivity. High retentivity is necessary for high output voltage at the frequency of maximum response. However, low retentivity is desirable not only from the viewpoint of reducing crosstalk but also from that of improving the response at the frequency of maximum response. The ratio of coercivity to retentivity is proposed as a figure of merit for estimating or predicting the frequency response of a medium when used with a specific magnetic recording system. The limitations imposed by the magnetic properties of the medium on the design of magnetic heads and magnetic recording systems are also discussed. The problem of modulation noise and its relation to the Barkhausen effect is emphasized because this may impose a serious limitation on the use of certain magnetic recording media which seem to be excellent in all other respects.

——— ——— *Ibid.*, Vol. 19, pp. 395–403; May. Definition of signal to noise ratio for magnetic recording systems; modulation noise, low value of which is necessary for high fidelity recording; background noise, crosstalk, and uniformity are other factors significant in choice of magnetic recording medium; ratio of coercivity to retentivity as figure of merit.

Horton, W. P., and Rubens, S. M. (Engineering Research Associates, Inc.), *Investigation of Solid Acoustic Delay Lines for the Storage of Digital Information.* PB 99666. 31 p.; June. The possibilities of storage of digital conformation in solid delay lines are discussed. Experimental results are given for delay lines of several types having delays of 100 to 1,000 microseconds. Using high ultrasonic carriers it is believed possible to store information at pulse rates greater than $10^6$ per second.

Howell, H. A., "Magnetic Sound Recording on Coated Paper Tape." *Society of Motion Picture Engineers Journal*, Vol. 48, pp. 36–46; (discussion, pp. 46–49); January. Application of coated paper tape as magnetic sound recording medium; special features of development which render it desirable for commercial uses; current trends in recorder design; brief summary of tape recorder performance is given, including dynamic range, frequency response, and distortion characteristics; special features of new recording medium relative to its use in motion picture industry. Bibliography.

Indiana Steel Products Company. *Hyflux Magnetic Recording Tape.* Engineering Bulletin no. EBT 101, 1947. Indiana Steel Products Co., Chicago, Ill.

James, J. H., "Magnetic Playback-Recorder Using Paper Discs." *Communications*, Vol. 27, pp. 32, 55–58; April. Describes portable magne-operated apparatus using the same head for recording and playing back. The paper disks are coated with a magnetic material of high coercivity which permits speech recording at 20 rpm with 40 tracks per inch. The track starts at the inside of the 9-inch diameter disk; the head is guided by a stylus running in a groove in a plastic disk 5½ inch diameter keyed to the spindle. The head is demagnetized automatically before playing back. A crystal unit is used as both recording microphone and playback receiver.

Klippel, K. L., and Dahl, E. A., "Railway Entertainment System." *Electronics*, Vol. 20, pp. 118–121; May. Quartz crystals in a double superheterodyne permit reception of pretuned distant stations when they become local to a train enroute. Design problems involve noise from power installations, limited antenna pickup, sensitivity, and acoustic distribution of received program material to passengers. Includes description of a remotely controlled receiver, independent ceiling amplifiers and loud-speakers, a wire record player and control boxes for controlling and setting up the desired program.

Kornei, O., "Frequency Response of Magnetic Recording." *Electronics*, Vol. 20, pp. 124–128; August. Magnetic properties, physical dimensions, and velocity of magnetic recording medium are discussed and evaluated; features and performance of electroplated wire and powder coated tape are described.

——— "Some Physical Aspects of Magnetic Recording." *Acoustical Society of America Journal*, Vol. 19, p. 280; January. The various factors controlling the performance of a magnetic record, *viz.*, magnetic properties of the recording medium, its physical dimensions and velocity, are discussed and evaluated. Based on these partially experimental, partially theoretical findings, a picture of the mechanism of longitudinal magnetic recording and reproducing is presented and a qualitative analysis of the frequency response curve given. Its shape is found to depend, for a given recording medium, on the effects of demagnetization, limited magnetic penetration, and the finite width of the exploring gap. The features of two improved recording media, namely the electroplated, and the powder coated type are described in the light of new findings.

Laden, L., "Robot Telephone." *Radio News*, Vol. 38, pp. 39–41, 102–104; August. Swiss-invented automaton, known as the Ipsophon, extends customary telephone communication facilities to include remarkable new electronic features including a magnetic sound system for the recording of messages.

Lippert, L., "Der Kopiereffekt der Magnetophonbander—eine Beispiel für eine Verallgemeinerung des Exponentialgesetzes." *Elektrotechnik*, Vol. 1, pp. 3–7; July; pp. 57–62; August.

Lyon, W. H., "Magnetic Tape Sound for Movies." *Home Movies*, Vol. 14, pp. 554–555, 580; September.

"Magnetic Paper Tape Recorder." *Radio News* (*Radio-Electronic Engineering Edition*), Vol. 8, pp. 15, 23; March. Hyflux, a paper tape coated with a metallic base magnetic powder, provides a new recording medium.

"Magnetic Recording of Sound." *Nature*, Vol. 159, p. 735; May 31. A short description of a lecture on "Developments in Magnetic Recording" given by Mr. P. T. Hobson to the British Sound Recording Association.

"Magnetophon Recorders." *Wireless World*, Vol. 53, p. 128; April. Brief notes on manufacture of plastic tape impregnated with iron oxide powders used in German system of magnetic recording. From report entitled "Magnetophon Sound Recording and Reproducing System" published by British Intelligence Objectives Sub-Committee.

Miller, Wesley C., "Magnetic Recording for Motion Picture Studios." *Society of Motion Picture Engineers Journal*, Vol. 48, pp. 57–62; January. Magnetic sound recording systems are belng investigated for possible application by the motion picture industry. With limited current literature and the general nature of present industry discussion, certain peculiar requirements for studio use have not been taken into account, but are outlined here. The discussion represents the opinion of one studio's sound department based on the present state of developments and the information at hand, but is, of course, subject to modification as experience and additional information are acquired.

"Motion Picture Innovations." *Science News Letter*, Vol. 51, p. 28; January 11. Magnetic recording of sound on motion picture films may replace other methods. Wire, paper disks, or tape are coated with magnetic material.

"New Recorders Challenge Disks." *Business Week*, p. 58+; April 5, 1947. News item.

O'Brien, R. S., "Adapting Paper Tape Recorders for Broadcasting." *Audio Engineering*, Vol. 31, pp. 10–14, 48; June. Describes the modifications required for greater utility in broadcasting service.

"Paper Tape Magnetic Recorder." *Tele-Tech*, Vol. 6, pp. 88–89; January. Hyflux, a new paper tape for sound recording in which the material receiving the magnetic impressions is a metallic base powder painted on the tape rather than an oxide.

"Pocket Magnetic Recorder." *Tele-Tech*, Vol. 6, p. 29; April. News item on pocket recorder developed by Brush Laboratories.

Ranger, R. H., "Design of Magnetic Tape Recorders." *Tele-Tech*, Vol. 6, pp. 56–57, 99–100; August. Review of German developments in magnetic tape recording as exemplified by their Magnetophon and Tonschreiber systems; particulars of improved American version known as Rangertone; advantages of tape recorder in broadcasting.

——— *Further Studies in Magnetophones and Tapes.* (Field Information Agency Technical Final Report 923) PB L 79558. 133 p.; May. This report gives information on the manufacture of three types of acetate tape for use with the Magnetophon system of sound recording and the type K7 Magnetophon is also discussed and there are included circuit diagrams for both the K7 and the K7 as modified by the Rundfunk Laboratories for broadcast use. The K7 Magnetophon is discussed and several uses of this equipment are described. Photographs, drawings, and circuit diagrams are included.

——— "Magnetic Tape Recorder for Movies and Radio." *Electronics*, Vol. 20, pp. 99–103; October. Particulars of new equipment using improved tape driven by three motors at speed of 30 inches per second which has over-all response flat within 4 db from 32 to 9,600 cycles; design considerations and circuits for record reproducer are shown and work spotter for editing is described; circuit diagrams and response curves indicated.

Read, Oliver, "Recording and Reproduction of Sound. Part 3." *Radio News*, Vol. 37, pp. 61–63, 102, 104, 106, 108; May. Introduction to basic methods for embossing sound on film and disk, magnetic recording on tape, disk, and wire, and optical film recording systems.

——— ——— Part 6. *Ibid.*, Vol. 38, pp. 57–59, 142–144, 146–148; August. Covering the theory and practice of various methods employed in magnetic recording on wire, tape, and nonmetallic, magnetically coated materials.

——— ——— Part 9. *Ibid.*, Vol. 38, pp. 48–50, 160–163; November. Magnetic reproducers—miscellaneous phono pickup comprise many types and varieties. These include magnetic, dynamic, moving vane, ribbon etc.

Reichsstelle für Hochfrequenzforschung, Berlin. *Reports on High Frequency Superconductivity, Magnetic Sound Recording.* (Field Information Agency Technical Microfilm Reel F8, Frames 1–329) PB L 74284. n.d. 329 f.

"Report on the Mail-A-Voice Magnetic Recorder." *Consumers' Research Bulletin*, Vol. 20, pp. 17–18; October. Not recommended.

Research Council Basic Sound Committee, "Discussion of Magnetic Recording." *Society of Motion Picture Engineers Journal*, Vol. 48, pp. 50–56; January. Notes on discussions held at two meetings of the Research Council Basic Sound Committee concerning the use of magnetic recording in motion picture studios. These meetings were held for a general discussion between the designers and manufacturers of magnetic recording and reproducing equipment and studio sound personnel for two reasons: 1) to allow the manufacturer to have an idea of the possible uses of their equipment and to obtain very general specifications on equipment to fulfill these uses, and 2) to allow studio personnel to obtain an idea of the present and possible future capabilities of magnetic systems.

Robin, H. L., *Magnetophon, Type K 7* (Field Information Agency Technical Final Report 841; Microfilm Reel BB183) PB 60743. 504 p.; January, 1947. This microfilm deals with current development on the new type K-7 Magnetophon, manufactured by the AEG in Germany, and includes a complete set of mechanical drawings required for manufacturing this equipment. All major and minor components are dealt with in detail in the construction drawings. In addition there is a brief description on the standard AEG nomenclature and drawing numbering system. There are detail drawings of about 400 parts, 1 wiring diagram, 8 parts lists, 4 order lists, 10 photographs, and winding data.

Roys, H. E., "Magnetic Recording." *International Projectionist*, Vol. 22, pp. 7–8; January. Brief discussion of recording method which has been in existence since 1901 when inventor, Valdemar Poulsen, first used it for recording wireless telegraph signals; data on typical frequency response of tape recorder; great advantage afforded by availability of immediate playback and reuse is pointed out.

Sear, A. W., "Soliloquy on Wire Recorder Wow." *Acoustical Society of America Journal*, Vol. 19, p. 289; January. A practical and mathematical consideration of several sources of wow in a wire recorder drive unit. The problem of driving an elastic recording medium at a constant velocity with a spool or capstan type of drive are considered and the limitations and requirements of the drives are discussed in some detail.

——— "Wire Recorder Wow." *Acoustical Society of America Journal*, Vol. 19, pp. 172–78; January. Discussion of variations in frequencies of tone reproduced by wire recorder resulting in flutter or wow; causes of flutter; amount of flutter that can be tolerated; analysis of side band components present when constant tone is frequency modulated by steady state wow or flutter condition; influence of arrangement of wire and spool as it bears on design.

Shaney, A. C., "Magnetic Tape Recording and the Record Collector." *American Record Guide*, p. 3; September.

——— "Magnetism. Part 1." *Radio Craft*, Vol. 19, pp. 28–29, 79–81; October. A modern view of permanent magnet theory including factors which influence the design and application of magnetic modulators (recording heads), magnetic detectors (playback heads) magnetic demodulators (obliterating heads), and their interrelation with the magnetic carrier (wire or ribbon) will be discussed in this and the succeeding article.

——— ——— Part 2. *Ibid.*, Vol. 19, pp. 30, 78–80; November. Elements of tape recording.

——— ——— Part 3. *Ibid.*, Vol. 19, pp. 36–37; December. Deals with recorder design.

"Sound Investment." *Die Casting*, Vol. 5, pp. 18–20, 35–40; February. Role of zinc and aluminum alloy die castings as components of WIRecorder designed and developed by WIRecorder Corp., to be combined with radio receiver for domestic use; operating and construction details.

"Standardization of Magnetic Recording." *Electronic Engineering*, Vol. 19, p. 396; December. Results of meeting arranged by B.B.C. to bring together manufacturers interested in magnetic recording based on German Magnetophon system and to discuss standardization of tape and equipment suitable for high fidelity sound recording.

Tinkham, R. J., and Boyers, J. S., "Magnetic Sound Recorder of Advanced Design." *Society of Motion Picture Engineers Journal*, Vol. 48, pp. 29–35; January. Apparatus described fills need for wire recording equipment of professional caliber; it has good frequency response, low distortion, freedom from wow and flutter, and lock-in synchronous drive; electrical and electromagnetic portions are result of war research; mechanical portions have many parallels in motion picture equipment design; apparatus is suitable for motion picture recording.

Wetzel, W. W., "Review of the Present Status of Magnetic Recording Theory." *Audio Engineering*, Vol. 31, pp. 14–17; November; pp. 12–16, 37; December; Vol. 32, pp. 26–30, 46–47; January, 1948. In a series of three articles Dr. Wetzel presents the first complete discussion of magnetic tape recording theory for engineers.

"Wire Recorder; Sears Roebuck Home Recorder Built into Radio-Phonograph." *Business Week*, p. 24; March 15, 1947. News item.

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Baruch, R., "High Fidelity Tape Recording." *Communications*, Vol. 28, pp. 16–17, 32–33, 37; November. Review of design and application characteristics of professional type tape recorders now available, editing practices and features and drawbacks of systems.

Begun, S. J., "Magnetic Field Distribution of Ring Recording Head." *Audio Engineering*, Vol. 32, pp. 11–13, 39; December. To gain better understanding of factors which might affect recording process, graphical study was made of magnetic field to which successive layers of active cross section of recording medium parallel to surface of pole pieces are subjected; analysis of results.

Bigwood, R. F., "Applications of Magnetic Recording in Network Broadcasting." *Ibid.*, Vol. 32, pp. 31–33, 38, 40; July. Used by American Broadcasting Company as magnetic tape equipment for recording and playing back on 1-hour delay basis, 18 hours of daily program material routed through its Chicago studios; use also for recording entire radio show and then editing to reduced time schedule; other possibilities of tape, its advantages over disks and standardization problems entailed.

Boyers, J. S., "Factors Affecting Frequency Response and Distortion in Magnetic Recording. *Ibid.*, Vol. 32, pp. 18–19, 46–47; May. Discussion of some factors affecting frequency response and distortion in magnetic recording on wire or tape and of methods of improving fidelity; hf response as affected by speed; magnetic characteristics of recording medium vs frequency response; effect of supersonic bias on recording head; cause of audible beats.

Camras, Marvin, "Magnetic Recording Tapes." *American Institute of Electrical Engineers Transactions*, Vol. 67, pp. 503–506. The properties of solid metallic tapes and coated tapes with paper or plastic bases are discussed and compared. The principal performance characteristics are: 1) frequency response; 2) max. snr; 3) output level; 4) sensitivity; and 5) erasability. 1) and 2) are largely interdependent as the snr determines the practical limit of equalization. The output level is generally higher for metallic than for coated tapes, except, in some cases, at high afs. The same applies as regards sensitivity, although the level of hf bias is a controlling factor. A tape recording can be erased by either a dc field; *e.g.*, a permanent magnet, or supersonic bias, the latter resulting in a quieter tape and one less liable subsequently to distorted recording. Tapes of high coercivity may require excessive field strengths for complete erasure. The characteristics of several different tapes are tabulated, of which one has a response flat within ±3 db from 50 cps to 7 kc at 8 in/sec with a snr better than 45 db.

——— "Magnetic Sound-on-Film." *Electrical Engineering*, Vol. 67, pp. 136–41; February. Simplicity of equipment required and adaptability of the process to 8-millimeter as well as 16- and 35-millimeter film are among the advantages claimed for magnetic recording of sound on motion picture film. Experimentally converted conventional projectors that can be used as recorders also are described.

——— "Magnetic Records for Home Entertainment." *National Electronics Conference Proceedings*, Vol. 4, pp. 47–53; November. This paper points out potentialities of the new method of "home recording"; in purchasing, renting, or reprocessing of recorded entertainment; in "voice snapshots" with pocket models; in stereophonic music; in amateur photography. A comparison with other kinds of recording shows that the magnetic method compares favorably in most respects, and is superior in many.

Carter, G. S., and Koontz, R., "Test Characteristics of Recording Wire." *Tele-Tech*, Vol. 7, pp. 38–40, 74–75; May. Review of wire characteristics test methods and performance revealing some of the problems in design and manufacture of magnetic recording wire; problems of wire breakage, erase failure, pool frequency response, wire noise, or hum and distortion; specification on Fidelitone wire.

Chevalier, A., "Enrégistrement sur Fil et Ruban Magnétiques." *Technique*, Vol. 23, pp. 675–79; December. Principle of sound recording on magnetic wire; data on motors of different recording apparatus, such as "Air King," "Wire Master," "Magnetape," and "Sound Mirror"; diagrams.

Clears, G. T., "Quasi-Technical Discussion of Magnetic Recording." *Radio News*, Vol. 39, pp. 52–53, 147–151; February. Basic principles involved in the design and operation of present-day wire and tape recording equipment.

Dimmick, G. L., and Johnson, S. W., "Optimum High-Frequency Bias in Magnetic Recording." *Society of Motion Picture Engineers Journal*, Vol. 51, pp. 489–99; November. Discussion, pp. 499–500. Experimental study was made of magnetic tapes and films produced by several manufacturers; effects of bias current upon frequency characteristic, reproducing level, and harmonic distortion are shown; conclusions are drawn as to best method of testing a given tape for optimum value of hf bias.

Fleming, Merle, "Converting a Brush Tape Recorder for Broadcast Use." *Radio News*, Vol. 39, pp. 59, 173; February. With minor changes, this tape recorder now meets broadcaster's requirements.

Frank, Ray, "Understanding the Wire Recorder." *Radio News*, Vol. 39, pp. 43, 152–153; February. An explanation of details and functions of the various parts of a typical recorder.

Goodell, J. D., "Sound on Tape." *Radio News* (*Radio Electronic Engineering Edition*), Vol. 10, pp. 3–5, 28–29; February. Development, manufacture, and testing of magnetic tapes suitable for the recording and reproduction of sound.

Hicks, L. S., "Basic Amplifier for a Wire Recorder." *Radio News*, Vol. 39, pp. 44–45, 168–169; February. Although designed for use with a specific wire recorder, this amplifier is basically the same as those used with all types of wire and tape machines.

Holmes, L. C., "An Evaluation of the Application of the New and Old Techniques to the Improvement of Magnetic Recording Systems." *National Electronics Conference Proceedings*, Vol. 4, p. 46; November. Abstract of paper presented at National Conference held in November, 1948. It is the purpose of this paper to discuss and evaluate several of the factors which contribute to high quality in magnetic recording systems and to show some data representing the performance characteristics which may now be obtained under the most favorable operating conditions.

——— *Investigation of Magnetic Recording Systems*. 27th monthly progress report for September, 1948. PB 104957. 6 p.; October.

Hust, L. B., "Build Your Own Magnetic Tape Recorder." *Radio News*, Vol. 39, pp. 39–42, 166–167; February. Complete specifications for the construction of a tape recording and playback unit.

"Inventory Taking Speeded by Wire Recorders." *Electrical World*, Vol. 130, p. 116; December 18. Southern California Edison has

used portable wire recorders to speed up inventory of general store equipment.

Jackson, C. E., "Magnetic Tape Systems." *Radio News*, Vol. 39, pp. 46–47, 140; February. The Brush "Soundmirror"—tape recorder suitable for either studio or home recording.

Javitz, A. E., "Magnetic Recording Media as Components in Product Design." *Electrical Manufacturing*, Vol. 41, pp. 82–7, 139–141; May. Types of magnetic media are tabulated and properties and applications are discussed; basic selection factors; comparative test data on selected specimens of magnetic recording media.

Kilian, L. G., "Data Recording on Magnetic Tape." *Electronic Industries*, Vol. 2, pp. 3–5, 31; April. Features of new recording system which uses magnetic tape to store variable or transient data under conditions of severe shock acceleration as high as 75 G's for later rerunning and analysis; sectional design enables tape recording to be done in vehicles, aircraft rockets or other mobile units; tape is then transferred to playback section and graphical record obtained directly.

Lindsay, H., and Stolaroff, M., "Magnetic Tape Recorder of Broadcast Quality." *Audio Engineering*, Vol. 32, pp. 13–16; October. Ampex Mold 200A high fidelity equipment described in detail; characteristics include full coverage of audible spectrum, low distortion, and great dynamic range; electronic system consists of four plug-in chassis units; power supply, relay chassis for controlling all operations, recording amplifier, and playback amplifier.

Masterson, E. "35-MM Magnetic Recording System." *Society of Motion Picture Engineers Journal*, Vol. 51, pp. 481–88; November. Idea was conceived of designing and building number of kits to add magnetic sound recording facilities to standard photographic recorder; this would enable studios to obtain practical experience without expense of complete film handling mechanism; mechanical and electrical components of kit and operational features are discussed as well as performance characteristics to be expected.

Norris, E., "Wire Recorders for Inventory." *American Business*, Vol. 18, pp. 12–13+; October. Dictaphone Corporation's idea of recording inventories instead of writing them has brought the wire recorders into many businesses to save time and money.

O'Brien, R. S., "'Edispot'—Spotting Device for Magnetic Tape-Editing." *Audio Engineering*, Vol. 32, pp. 11–13, 46; July. Notes on C.B.S. editing spotter and amplifier; tape may be reeled forward and backward with output of pick-up head being reproduced through amplifier; with tape stopped at desired section, drum may be rotated so head scans short length of tape continuously repeating that section; output is observed on oscilloscope, together with marker pip keyed exactly as head passes "Mark" arrow.

O'Dea, D., "Magnetic Recording for Technician." *Society of Motion Picture Engineers Journal*, Vol. 51, pp. 468–80; November. Magnetic recording theory reviewed; experimental data taken with new magnetic recording equipment of Radio Corporation of America are presented; input-output, frequency response, and distortion data taken under test conditions familiar to motion picture technicians, are presented; attempt is made to consolidate information in literature. Bibliography.

"Paper Sound Recording Tape." *Pulp and Paper Magazine of Canada*, Vol. 49, pp. 56–57; April. Recent interviews reveal that problems of producing high quality paper sound recording tape have been solved, paving the way to a new and impressive market for specially treated paper.

Pulling, M. J. L., "Sound Recording as Applied to Broadcasting." *B.B.C. Quarterly*, Vol. 3, pp. 108–121; July. A detailed description of the practical attributes required of any recording and reproducing system; at present, however, no system meets all these requirements. Three basic recording systems exist—mechanographic, magnetic, and photographic. The two former are described in detail with their particular advantages and disadvantages for different purposes. A description is also given of the requirements for mobile equipment and of one recently developed.

Ranger, R. H., and Kunnapfel, R. H., "Drive Mechanism for High Fidelity Magnetic Tape Recorder." *Product Engineering*, Vol. 19, pp. 125–26; August. Abstract of paper presented at the 1948 American Institute of Electrical Engineers General Meeting, Pittsburgh, Pa. Specially modified induction motors give a relatively smooth, constant speed, constant tension drive for a high fidelity tape recorder. Carefully balanced torque characteristics of the motors avoid the use of complicated control circuits.

——— "Ingenious Drive Mechanism." *Ibid.*, Vol. 19, pp. 125–26; August. Operating features of specially modified induction synchronous drive motor system for high fidelity tape recorder; speed torque characteristics. From "Drive Mechanism for High Fidelity Magnetic Tape Recorder," before American Institute of Electrical Engineers.

Ranger, R. H., "New Tape Techniques." *FM and Television*, Vol. 8, pp. 40–41; December. Examples of improved methods employed by fm broadcasters and others with particular reference to use of Rangertone recording equipment; use of tape at station KSBR, San Bruno, California.

——— "Performance Features New Magnetic Tape Recorder." *Tele-Tech*, Vol. 7, pp. 40–42, 64–65, 72; October. Full speed range, adjustability, quality recording are some characteristics of Rangertone model; suitable for duplication of recording for fm networking.

Read, Oliver, "Recording and Reproduction of Sound. Part 12—Design of Magnetic Tape Recorders." *Radio News*, Vol. 39, pp. 56–58, 131–132, 134–136, 138–140; February. An analysis of the mechanical and electrical requirements in the design of magnetic tape recorders.

Schueller, E., "Das Magnetophon." *Verein Deutscher Ingenieur Zeitschrift*, Vol. 90, pp. 120–124; April. Magnetophon; description of apparatus with which it is possible to record spoken word on magnetizable strip; its predecessor is speaking steel wire; sound carrier is strong film strip only 50/10 mm thick and 6.5 mm wide with layer of tiny iron oxide particles, which can be repeatedly magnetized; main application is in broadcasting, where recordings are retained on Magnetophon strip; other applications.

Shaney, A. C., *Elements of Magnetic Tape Recording—and 999 Applications*. New York, Amplifier Corp. of America, 32 p.; January. Presents the essentials of the elements of magnetic tape recording and hints on some of its possible applications to the layman, technician, engineer and others engaged in arts, sciences and industries.

——— "Magnetic Recording. Part 4." *Radio Craft*, Vol. 19, pp. 31, 54, 76–78; February. The electronic section of a modern magnetic recording and playback apparatus.

——— ——— Part 5. *Radio Craft*, Vol. 19, pp. 35, 69–70, 77; March. Construction of the recording-erase heads and tape-puller.

"Stereophonic Sound." *Electronics*, Vol. 21, pp. 88–89; August. How magnetic tape carrying three simultaneous channels may afford striking illusion of presence when played back through properly oriented speakers; experiments indicate feasibility of two channel home system in one cabinet; brief details of system.

"Twin-Trax Magnetape Recorder." *Review of Scientific Instruments*, Vol. 19, p. 537; August. A short news item describing a magnetape recorder utilizing two separate recording tracks on standard 1/4 inch wide magnetic tape.

Vermeulen, R., "Duplication of Concerts." *Philips Technical Review*, Vol. 10, pp. 169–177; December. Discusses the difficulties to be overcome in presenting music directly to large audiences, and concludes that the only economic method is by electro-acoustic methods. A brief description is given of stereophonic equipment for the simultaneous duplication of concerts in a number of halls. The Philips-Muller equipment has a level response up to 8 kc. The music is picked up by 6 microphones each having its own control chain and reproduced through 3 loudspeakers. The majority of listeners agreed that the entertainment was of much higher value than ordinary broadcast reception and the stereophonic effect a great advance. Sound level was fairly critical and it was found the control engineer tended to emphasize the bass too much. Opinion as to whether absence of the orchestra was noticeable was evenly divided.

Vinzelberg, B., "Über den Kopiereffekt der Magnetofonfilmbänder." *Funk und Ton*, Vol. 12, pp. 633–640; December. When some types of magnetophone tapes are coiled, a strong signal on one portion of the tape may be copied into the other portion. The dependence of this copying effect on time, signal frequency, temperature and type of tape is illustrated by experimental results.

West, C. F., and De Turk, J. E., "A Digital Computer for Scientific Applications." PROCEEDINGS OF THE IRE, Vol. 36, pp. 1452–1460; December. Describes the magnetic memory units' use of magnetic tape as a permanent continuous storage medium.

Wiegand, D. E., "Testing of Magnetic Recording Media." *American Society for Testing Materials*. Preprint 30a for meeting of June 21–25, 1948. 12 p. Three types of measurement used at Armour Research Foundation are listening tests, measurements of final performance characteristics, and basic magnetic measurements; listen-

ing tests are performed on conventional magnetic recording apparatus; final performance measurements made on special tester; basic magnetic measurements are made on cathode ray hysteresis loop tracer powered at 60 cycles.

——— and Zenner, R. E., "A Turn-in-Gap Erase Head for Magnetic Recorders Providing Intense High-Frequency Fields." *American Institute of Electrical Engineers Transactions*, Vol. 67, pp. 507–510. A new head provides a reasonable power input, much more intense erasing fields than were possible previously and thus makes the use of magnetically harder media feasible. This head is excited by a single conductor in the erasing gap. The gap conductor is energized by a single-turn secondary winding of a transformer. Greater efficiency is achieved through the resulting reduction in head flux for a given mmf applied to the medium. Improved thermal characteristics increase the power handling ability of this head.

Zenner, R. E., and Vaile, R. B., "Two-Channel Two-Way Drive Magnetic Tape Recorder." *Audio Engineering*, Vol. 32, pp. 11–15; April. Description of Armour Research Foundation demonstration unit designed to give excellent performance at low tape speed; Armour no. 140 magnetic material was selected for tape because of its good recording characteristics combined with ease of ac erasing; tape speed of 8 inches per second used; circuits are designed for 500 ohms, 1-mw input and output; circuit diagram; construction details; frequency response.

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Begun, S. J., "Limitations of Sound Recording." *Communications*, Vol. 29, pp. 28–29, 33–34; August. Discussion of high fidelity system requirements; major causes of distortion; results to be expected from practical recording setup; characteristics of powder coated tapes; economic considerations in recording; mechanical factors; problems of the future.

——— "*Magnetic Recording*." New York, Muarry Hill Books, 1949. 242p. Detailed discussion of fundamentals and components of efficient magnetic recording devices; theory, various types and makes of recorders, their applications and performance measurements are all treated. Bibliography.

——— ——— *FM and Television*, Vol. 9, pp. 28–30; May; see also *Scientific Monthly*, pp. 192–197; September. Performance characteristics and standards for magnetic equipment; discussion covers: features of tape recording, types and cost of equipment, merits of tape and disk methods, hum and noise, variations of level, and standards of performance.

Begun, S. J. and others, "Measuring Procedures for Magnetic Recording." *Audio Engineering*, Vol. 33, pp. 19, 41–43; April. Tentative standards, submitted by a special sub-committee of the Radio Manufacturers Association for measuring magnetic recording.

Booth, A. D., "Magnetic Digital Storage System." *Electronic Engineering*, Vol. 21, pp. 234–38; July. Magnetic sound recording device for storage of digital data for parallel operation calculating machines; cylindrical drum coated with magnetic material rotating under series of read/record heads arranged along generator of cylinder; discussion of magnetic memory circuit and mechanical construction, diagrams and photographs.

Camras, M., and Herr, R., "Duplicating Magnetic Tape by Contact Printing." *Electronics*, Vol. 22, pp. 78–83; December. Process whereby recorded master and tape to be printed are run through controlled alternating field at high speed with magnetic surfaces in direct contact for almost perfect transfer of recorded material without demagnetization of master, offering promise of low cost prerecorded reels. Before National Electronics Conference.

Camras, M., "Graphical Analysis of Linear Magnetic Recording Using High-Frequency Excitation." PROCEEDINGS OF THE IRE, Vol. 37, pp. 569–73; May. Addition of hf component to audio signal to be recorded magnetically results in low distortion linear recording characteristic under certain conditions; methods for constructing recording characteristic from $B_R/H$ vs $H$ curve of record material; analysis accounts for such magnetic recording characteristics as variation in sensitivity with bias, linearity at low recording levels and adjustments.

——— "A New Magnetic Record Duplicating Process." *National Electronics Conference Proceedings*, Vol. 5, pp. 258–61; September. Magnetic records can be faithfully duplicated at high speed and in large quantities by a contact printing process. The program is first recorded on a master tape of high magnetic properties. This master is then held against a blank magnetic tape while the two are subjected to a "transfer field." When the copy tape is separated from the master, it retains an accurate reproduction of the magnetic recording from the master. This new method promises to be widely used for magnetic record releases.

——— "Stereophonic Magnetic Recorder." PROCEEDINGS OF THE IRE, Vol. 37, pp. 442–47; April. Data on high quality 3-channel recorder and playback unit built for experimental work, to determine requirements of unit suitable for home entertainment; results of tests indicate that two channels are adequate for small room and that control track for volume expansion is unnecessary; experiments made with loudspeaker and microphone locations show best results with "dihedral" mounting of two loudspeakers.

Cooter, I. L., "Magnetic Fields Surrounding Recording Wires." *Electrical Engineering*, Vol. 68, p. 433; May. Some applications of magnetic recording require storage of information in form of coded pulses in magnetic media such as wire or tape; to conserve space, greatest number of pulses possible must be recorded in each linear inch of medium without pulses losing distinctness or blending with preceding or succeeding pulses; studies of magnetizing current, pulse width and frequency as related to this blending were made. Digest of American Institute of Electrical Engineers paper 48-237.

"A Demonstration Studio for Sound Recording and Reproduction and for Sound Film Projections." *Philips Technical Review*, Vol. 10, pp. 196–204; January. The studio is equipped for demonstrations of various types of program sources, amplifiers, loudspeakers and film projection equipment, as well as for sound recording by different systems. The acoustic properties are such that the reverberation time at the high frequencies (0.9 sec at 2,000 cps) is only slightly less than at the lower frequencies (1.3 sec at 100 cps), this having a very beneficial effect on the high note response. An elaborate relay system permits of any combination of a sound source (microphone, "Philimil" tape, magnetic tape or radio receiver), an amplifier, and one or more loudspeakers. From the control desk one or several programs can be passed to different recording equipment, *viz*, the Philips-Muller, the magnetic or the photographic equipment, or the gramophone recording unit. Arranged round the studio itself are a microphone room, "speech studio," projection, control, and recording room.

"Dependable Driving and Braking Mechanism Built with Die Castings." *Die Casting*, Vol. 7, pp. 28–31, 54; December. Illustrated description of wire recording unit manufactured by Lear, Inc., Grand Rapids, Michigan; mounting base, housing and large number of components are die cast; operating principles; power transmission; production methods; typical parts of driving and braking system die cast in zinc are shown.

Edwards, A., and Knight, F., "Magnets for Radio." *Wireless World*, Vol. 55, pp. S16–19; June. Influence of new alloys on design of components; anisotropic magnetic materials; field strengths of loudspeaker magnets; designs for microphones, phonograph pickups, televsion lenses, magnetic recording and magnetron oscillators; diagrams.

Enkel, F., "Operational Measurement of Periodic Frequency Fluctuations in Magnetic Sound Recording." *Funk und Ton*, Vol. 3, 104–106; February (In German). Describes a method of measuring the particularly troublesome fluctuations having a frequency of 1–5 cps. A constant frequency note is recorded, and in the reproducer a second frequency differing by 50 cps is superposed. The combined output is applied through a rectifier, low-pass filter and amplifier to a reed frequency meter reading 45–55 cps. The number of reeds responding indicates the range of frequency fluctuation, and the ratio of this range to the constant frequency supplied gives the fractional fluctuation set up in the recorder and reproducer.

Frayne, J. G., "Magnetic Recording in Motion Picture Techniques." *Society of Motion Picture Engineers Journal*, Vol. 53, pp. 217–34; discussion, pp. 234–35; September. Development of magnetic recording at Bell Telephone Laboratories is described with application of such facilities to Western Electric recording and reproducing systems; method of driving 35-mm magnetic film with flutter content not greater than 0.1 per cent is described, as is multigap erasing head.

"General Electric Magnetic Tape Recorder." *Engineer*, Vol. 188, pp. 198–99; August 19.

Goron, I. E., "Soviet Designs of Apparatus for Magnetic Sound Recording." *Akademiia Nauk. Leningrad. Izvestiia. Seriia Fizicheskaia*, Vol. 13, pp. 662–665 (In Russian).

Gratian, J. W., "Noise in Magnetic Recording Systems as Influenced by the Characteristics of Bias and Erase Signals." *Acoustical Society of America Journal*, Vol. 21, pp. 74–81; March. Causes of

noise generated by conventional supersonic biasing and erasing fields used in magnetic recording systems; manner in which noise varies with wave form and frequency of applied supersonic field; relation of noise to characteristics of erase and recording heads and to inherent frequency response and modulation noise characteristics of medium. Bibliography.

Gunby, O. B., "Portable Magnetic-Recording System." *Society of Motion Picture Engineers Journal*, Vol. 52, pp. 613–18; June. Review of progress in synchronous magnetic recording since it was first demonstrated in May, 1948 using 35-mm perforated magnetic stock operating at standard film speed of 90 fpm; design specifications for portable applications are discussed.

Harris, C. C., "Portable Magnetic Tape Broadcasting Recorder." *Communications*, Vol. 29, pp. 6–7; December. Description of equipment used at station WIP Philadelphia, Pa.; one man unit, weighing 12 pounds has been found ideal for remote broadcasts permitting 15 minutes recording at 7 1/2 inches per second and 7 1/2 minutes recording at 15 inches per sec; recorder has flat response between 100 and 5,000 cycles with less than 3 per cent total harmonic distortion; circuit diagram.

Haynes, N. M., "Magnetic Tape and Head Alignment Nomenclature." *Audio Engineering*, Vol. 33, pp. 22–23; June. Suggested terminology for expressing causes of malfunctioning of experimental and commercial tape recorders.

Herr, R., "Duplication of Magnetic Tape Recordings by Contact Printing." *National Electronics Conference Proceedings*, Vol. 5, pp. 262–68; September. A new method is described for copying magnetic recordings without electrical transcription. Unrecorded tape is subjected to a controlled alternating magnetic field while in contact with recorded tape, and thereby magnetized directly, in a manner analogous to the pressing of disks. When optimum master and print media are used the recording is nearly, if not quite, as good as can be obtained by playback and re-recording. Because of the simplicity of the operation and the speed with which it may be carried out it is expected to make the large scale production of prerecorded program material practical from an economic point of view.

——— ——— *Tele-Tech*, Vol. 8, pp. 28–30, 57; November. Method of copying which does not involve electrical transcription or require record or reproduce heads of any kind; how magnetization of successive tapes is enhanced by "idealization" process, in which alternating field is superimposed on print tape along with direct field of recorded magnetic tape; process details and advantages.

——— "Magnetic Tape Erasure by Permanent Magnets." *Audio Engineering*, Vol. 33, pp. 14–16, 29–30; August. Discussion of requirements for good erasure and use of permanent magnets: how application of dc pulses may be used to obtain erasure almost comparable to results possible with ac bias, providing conditions are carefully controlled.

——— and others. "Some Distinctive Properties of Magnetic-Recording Media." *Society of Motion Picture Enigneers Journal*, Vol. 52, pp. 77–87; Discussion, pp. 87–88; January. Information on readjustment of bias current in magnetic recordings and various effects of bias changes on distortion, frequency response, overload characteristics, and permanency; other factors which influence frequency response are outlined and it is shown that inherent frequency response of medium is difficult to divorce from effects due to recording system.

Holmes, Lynn C., "Techniques for Improved Magnetic Recording." *Electrical Engineering*, Vol. 68, pp. 836–41; October. Techniques which may be used to improve frequency response, reduce distortion, and increase signal-to-noise ratio of magnetic recording systems; new methods of measurements by which those improvements may be evaluated; some of present limitations of magnetic recording are pointed out, and suggestions given as to possible methods of overcoming those same limitations. Given before the National Electronics Conference.

Johnson, S. W., "Factors Affecting Spurious Printing in Magnetic Tapes." *Society of Motion Picture Engineers Journal*, Vol. 52, pp. 619–27; Discussion, pp. 627–28; June. Study to determine amount of spurious printed-through signal from adjacent layers in roll of tape; effects of time, temperature, and output level of original recording are taken into consideration and conclusions are drawn.

Jorysz, A., "Portable Tape Units." *FM and Television*, Vol. 9, pp, 24, 30; November. Presto PT-900 equipment for broadcasters etc. manufactured by Presto Recording Corp. described; unit, together with power supply, has total weight under 80 pounds; design details of record-proper; features of amplifier and power-unit.

Kolb, O. K., "Magnetic Sound and the Film." *British Kinematography*, Vol. 15, p. 37; August.

Korhone, Edward D. and others, *Preparation and Characteristics of Magnetic Recording Surfaces*. Engineering Research Associates, St. Paul, Minn. PB 99842. 24p., January, 1949. Photos, drawings, graphs.

Larsen, J. A., "Magnetic Device for Cuing Film." *Society of Motion Picture Engineers Journal*, Vol. 52, pp. 326–332; March. Discusses the problems of cuing films and the present methods in use. A new system is described in which a small spot of magnetic material is painted on the edge of the film instead of the present method of cutting a notch out of the edge. The pulse picked up by a magnetic detector is used to control light changes, fades, etc. The magnetic paint consists of $H_2$-reduced powdered iron, clear finger-nail polish, and acetone and dries in 20 seconds. The advantage of this is that it tends to dissolve the film and when dry is very firmly cemented on. It is suggested that the new device may help to standardize 60 mm printing work.

Ledbetter, J. B., "Adapting Home Recorders for Professional Use." *Radio and Television News*, Vol. 41, pp. 47–49+; February. A few simple changes can lift the popular home recorder into the "professional" recorder class.

"Magnetic Band and Wire Recorders (Om magnetiskiog traadoptagere)." *Radio Ekko;* May.

"Making Magnetic Recordings Visible." *Audio Engineering*, Vol. 33, p. 23; April. Describes a variation in technique for making magnetic recording sound tracks visible.

Marchant, Reynolds, "Duplicating Tape Recordings." *Electronics*, Vol. 22, pp. 72–76; July. Pilot-model duplicator places program material on eight reels of two-track tape simultaneously as prelude to mass duplication of tape records for home entertainment. Doubling supersonic-bias frequency permits recording at twice playback speed, lowering cost.

——— "Tape Characteristics for Audio Quality." *Tele-Tech*, Vol. 8, pp. 30–33, 56–57; July. Measurement of characteristics of magnetic material such as their coercive force and remanence; effort being made by members of the NAB Magnetic Tape Committee to standardize playback characteristics of various commercial machines; proper operational, storage and handling techniques for obtaining uniform high quality recordings.

Marsh, W., "Tape Recorder Time Clock Control." *Communications*, Vol. 29, pp. 24, 34–35; April. Details of modified cape recorder control unit which permits automatic recording of air check programs; system described can also be applied to other remotely operated tape installations.

"Mass Production Tape Recording." *Audio Engineering*, Vol. 33, pp. 21, 27; April. Notes on machine perfected by Minnesota Mining and Mfg. Co., St. Paul, Minn., that can simultaneously reproduce 48, hour long tape recording indistinguishable from master transcription in one hour; re-recorded reels of tape will be designed to compete with disk records for use in home, in broadcasting, in schools and theaters.

"Measuring Procedures for Magnetic Recording." *Ibid.* Vol. 33, pp. 19, 41–5; April. Recommendations of subcommittee of Radio Manufacturers Association Committee on Phonograph Combination and Home Recording, respecting measuring procedures for magnetic recording; measurements of frequency response of unequalized system, distortion, and noise.

Mittell, B. E. G., "Development of Magnetic-Tape Recorder." *Institution of Electrical Engineers Proceedings*, Vol. 96, Part 3 (Radio and Communication Engineering) no. 42, pp. 305–06; July; see also *Engineer*, Vol. 187, p. 313; March 14. First magnetic recorder, Telegraphone, invented by V. Poulsen of Copenhagen in 1899; principles underlying supersonic methods of erasing and biasing revealed by researches of Ewing and others around 1880; Ewing's work on hysteresis; operation of magnetic tape recorder; difficulties in attaining good high frequency response at reasonable tape speeds. Radio Section informal lecture at joint meeting with Acoustics Group of Physical Society.

Montani, A., "Mechanism of the Supersonic Bias." *Electrical Engineering*, Vol. 68, p. 511; June. Describes the nonlinear relationship between exciting current and the flux generated in magnetic alloys as a source of difficulty in the design of magnetic devices and circuits including magnetic recording.

Mueller, W. A., and Groves, G. R., "Magnetic Recording in Motion Picture Studio." *Society of Motion Picture Engineers Journal*, Vol.

52, pp. 605–12; June. Improvements and economies which magnetic recording effects; use in original production recordings, talent testing and coaching, playbacks, re-recordings, foreign versions, publicity recordings, reverberation control, anticipated noise reduction, newsreel single system recording, and "electrical printing."

Murphey, B. F., and Smith, H. K., "Head Alignment with Visible Magnetic Tracks." *Audio Engineering*, Vol. 33, pp. 12–13, 38–39; January. In recording on tape it is necessary to align recording and reproducing head gaps to certain degree of parallelism and to make gaps perpendicular to edge of tape; technique developed to obtain these alignments; approximation for amplitude loss due to skew gaps; microscopic examination of recorded track.

"New Professional Tape Recorder." *Tele-Tech*, Vol. 8, pp. 34–35, 64; March. Constructional features of Fairchild Recording Equipment Corp.'s Model 100 Recorder which combines top quality performance with low tape speed and simplifies editing and spotting, provides for exact cuing, and eliminates most, if not all, of operational objection heretofore considered inherent in magnetic tape machines.

Olson, M. N., "Multiple Tape Recording." *FM and Television*, Vol. 9, pp. 30, 32; March. Notes on Minnesota Mining and Mfg. Co.'s new recording machine on which eight tape copies with single or double sound tracks can be run off simultaneously; machine can produce up to 48 hours of recorded music on tape per hour by transferring sound from master tape.

Pennsylvania University. Moore School of Electrical Engineering. *Functional Description of the EDVAC*. Vol. 1. PB 110330. 206p.; November.

——— ——— Vol. 2. PB 110331. 186p.; November. The two volumes cover the functional description of the EDVAC which is an automatically sequenced serial binary electronic digital computer. It has a high-speed memory of 1,024 words and a low-speed memory, originally designed to have a capacity of about 150,000 words. The entire memory, both low- and high-speed, is under complete automatic control, and any portion of it may receive data from the computer, or omit data to the computer or the dispatcher.

Read, O., *Recording and Reproduction of Sound*. Indianapolis, Ind., Howard W. Sams and Co. 364p.; 1949. Book covers essential requirements for complete understanding of various aspects of sound and their relation to recording techniques and methods of reproduction; theoretical considerations explained and translated into practical descriptions, instructions, and advice; proposed terminology and standards, glossary, bibliography of magnetic recording and other useful information included.

Roe, D., "Magnetic Recording Technique." *Wireless World*, Vol. 55, pp. 362–64; October. Practical aspects and operating techniques of magnetic wire and tape recording; erasing and playback heads; frequency response of recording system; superimposition of steady high frequency tone on audio signal while recording for increased volume range; reduction of playback noise, diagrams.

"Safety Engineer Becomes Superman by Means of Unit for Recording and Reproduction of Safety Messages." *Safety Engineering*, Vol. 97, pp. 31+; April; *National Safety News*, Vol. 59, pp. 24+; May. Describes a simple mechanism for handling a magnetic tape on which a safety message is recorded for use through public address systems.

"Safety on the Wire; Recorded Safety Talk Reproduced at Meetings." *Ibid*, Vol. 59, pp. 26–27; April. Wire recorder adds realism to messages of absent officials at scattered meetings of the Texas Company.

Schiesser, H., "Devices for Time Extension of Sound Reproduction." *Funk und Ton*, Vol. 3, pp. 256–60; May (In German). In light of magnetic recording, of which the latter only is considered, the overall reproducing time is fixed by the speed of the recording material; *e.g.*, film or tape, but, indepdently of this, the pitch can be raised or lowered with respect to the original recording by use of one or more rotating reproducing heads, each of which scans in turn a portion of the moving tape. Inevitably there are either gaps between the individual scanned elements or overlapping portions, depending upon whether the heads rotate in the same direction as that of the tape movement (pitch lowered) or opposite to it (pitch raised), but these discontinuities are not detectable aurally if the elements are sufficiently small. Two types of rotating head units are described, one having 4 heads set at 90° to one another with a center commutator to which the head cores are connected, and the other consisting of a rotating ring of magnetic material with 4 symmetrically disposed air-gaps, against the inside of which one stationary head presses, thus forming a magnetic commutator. This technique is useful for reducing the reproduction speed of dictating machines without lowering the pitch, for speeding up the rate of transmission of a specific amount of information, and for research in phonetics.

*Sound Recording and Reproduction* (*Magnetic Tape Systems for Broadcasting*). British Standard no. 1568, 10p. The standard provides definitions and deals with dimensions of tape, tape guides, tape speed, sense of winding, types and playing-time of reels; it also specifies requirements for reels, for program identification, and for checking frequency response.

Springer, A., "Advances in Magnetic Recording." *Frequenz*, Vol. 3, pp. 38–47; February (In German). Standard modern practice is described, with an account of the following: 1) multichannel recording, using multiple tracks, with particular reference to stereoscope working. The sources of crosstalk and its suppression are discussed and the desirability of employing at least three, and preferably more, microphones, with correct mixing, for realistic reproducing is stressed; 2) maintenance of constant and accurate tape speed. Type of drive, satisfactory capstan friction, variation in load with change in diameter of the tape reel, and tape stretch are important factors here. A method of speed checking with a tube-maintained fork and a cro is described; 3) fast multiple re-recording. The inevitable reduction in dynamic range is underlined; 4) the use of rotating heads for sound analysis, etc.; 5) automatic speed regulation by means of frequency-meter control; and 6) transfer simplification of equipment, etc.

Stewart, W. E., "New Portable Tape Recorder Performs with Studio Quality." *Tele-Tech*, Vol. 8, pp. 40–41, 50, 51; April; see also *Broadcast News*, April. How RCA's RT-3A portable magnetic tape recorder is designed to fulfill broadcasters' needs for light-weight low cost recorder with true studio quality; unit features automatic speed frequency equalization; constructional and operating details.

Stolaroff, M. J., "Low-Cost Precision Magnetic Recorder for Professional Use." *Audio Engineering*, Vol. 33, pp. 17–18, 30–31; August. Design particulars of Ampex Magnetic Tape Recorder Model 300; how precision in manufacture and utilization of new design techniques results in recorder which compares favorably with most elaborate units in field.

Stolaroff, M. J., *Magnetic Recording—Drive Systems, Recording Heads, Circuits*. Paper presented at the fall lecture series, December, 1949. New York, Audio Engineering Society. Not published; available in photoduplicate form, 104 Liberty St., Utica, New York.

Thompson, C. S., "Application of Experimental Test Procedures and Methods of Analysis of Results to Research Problems in Magnetic Recording." *American Institute of Electrical Engineers Transactions*, Vol. 68 (Part 1), pp. 407–17; see also *Electrical Engineering*, Vol. 68, p. 793; September (Digest). Discussion of text techniques in recording and results obtained; theory of recording process; importance of characteristics of recording medium; component characteristics influencing over-all fidelity; evidence showing that magnetic skin effect, as function of core lamination thickness, is more important than hitherto believed; criteria for judging operating excellence.

Vinzelberg, B., "The Dynamic Range of the Magnetophon." *Elektrotechnik*, Vol. 3, pp. 79–80; March (In German). The "working" dynamic ranges of magnetic tapes, though increased by the substitution of hf for dc erasure and bias, are not as great as the "static" (Ruhedynamik) values. Such values are based on the noise level hf bias level curves and while the working dynamic range, *i.e.*, that with af signals added, will certainly be at least 12 db<the static range, the loss may occasionally be much more. It is suggested that this effect is due, not to any tape irregularities, but to insufficient time for the bias to affect all the magnetic elements. Since noise levels resulting from either a dc or an af current in the recording head are similar, an easy method, using dc of determining the working dynamic range is suggested.

"Wire Recorder Techniques; Unique Uses." *Electronics*, Vol. 22, pp. 160+; January. Wire recorders are being used in Vancouver, B.C. for exterminating rats.

Wroblewski, T., "Design Considerations for Magnetic Wire Recording." *Sylvania Technologist*, Vol. 2, pp. 6–11; January. Basic design considerations for magnetic recording and reproducing; discussion of recording, reproducing and erasing head, wire spooling mechanism and associated electrical apparatus; scope of problems in designing complete magnetic recording and reproducing system.

Zeluff, Vin, "Egg Records on Wire." *Electronics*, Vol. 22, pp. 162, 164; February. Complicated egg laying records are kept at a small cost by the use of wire recorders.

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Amthor, F. R., "Mirror for Mistakes; Electric Recorders Valued as Agent Training Device." *National Underwriter (Life edition)*, vol. 54, p. 8; December 1.

Askew, F., "Load Impedance Input for Brush Recorder." *Tele-Tech*, Vol. 9, pp. 30–31; May. A brief description of a method of modifying a Brush Soundmirror tape recorder for use with low impedance microphones.

"Automatic Train Announcing Apparatus." *Railway Gazette*, Vol. 93, pp. 181–183, 189; August 18. To meet requirements of London Transport executive, Westinghouse Brake and Signal Co. has developed apparatus to convey information to public at stations; it can be adapted to other purposes where such announcements need to be made; magnetic tape recording is used to store different announcements, provision being made for each to have max. possible duration of 45 seconds with facility for splitting it into two parts with break of any desired time between; recording made on plastic tape.

Axon, P. E., "Overall Frequency Characteristic in Magnetic Recording." *B.B.C. Quarterly*, Vol. 5, pp. 46–53. Tests to determine the demagnetization effect in recorded tape and the results thereof are discussed. Recording characteristics taken in the upper af region and beyond show successive falling maxima and minima arising from the gap effect, and the maxima alone are then plotted to show the combined effect of demagnetization and head losses. To avoid errors due to a grossly incorrect estimation of the effective reproducing gap width, a wide gap is employed, *e.g.*, 0.4 mm. The fact that a given drop in level below the lower frequency datum level corresponds to the same wavelength on the tape for different tape speeds indicates that head losses are negligible compared with those of demagnetization. Comparable curves of this type are given for four different tapes and it is shown how they can be utilized to determine the correct gap width and so obtain a desired response from a given tape.

Blakesley, Jay, "Performance Plus Economy Tape Recorder." *Audio Engineering*, Vol. 34, pp. 20, 47–48; November. How modification was made to existing equipment to provide tape recorder of suitable quality for broadcast use and with minimum of expenditure for new material; use of RCA 70-A turntable and amplifier parts taken from Brush BK-401 tape recorder; circuit details, diagram and parts list.

Boothe, K. S., "Uses of Magnetic Tape Recording in Telemetering." *Instruments*, Vol. 23, pp. 1186–88; November. Data on fm-fm system in which number of sensory elements are used to pick up and translate various types of information into electrical terms, quantities measured being transmitted simultaneously over wire or radio link; advantage of magnetic tape recording is its frequency response; use of multichannel recording.

Camras, Marvin, "Magnetic Sound on 8 mm Film." *Tele-Tech*, Vol. 9, pp. 25–27; May. Problem of how to put sound on sub-standard film has not been satisfactorily solved in past; new approach made by depositing magnetizable strip on edge of motion picture film; not only new films but also old reels can have magnetic track added since track is outside of picture area; technical problems involved.

Carter, H. W., "Frequency-Controlled Rotary Converters." *Audio Engineering*, Vol. 34, pp. 18–19; June. Design and performance of converters used as portable power supply for broadcast remote wire and tape recordings; unit is ideally suited for emergency recordings of sporting events, interviews, and other "on spot" broadcast material; converter delivers 60-cps output at full rated load at highest input voltage that will be encountered, *e.g.*, 6.5 v or 12.7 or 132 v dc.

Cooter, I. L., "Pulse Packing in Magnetic Recording Wire." *U.S. Bureau of Standards Journal of Research*, Vol. 44, pp. 163–172; February. An oscillographic method is described for determining the relative pulse packing of different types of magnetic recording wire used for pulse storage. Typical curves given show the influence of the amplitude, duration and repetition rate of the magnetizing pulses on the pulse packing in two types of recording wire. A powder pattern method is also described for visually observing the length of magnet is produced in the wire by the magnetizing pulses. Photographs are shown of typical patterns. The data obtained verify the pulse packing data obtained by the oscillographic method.

Crane, G. R. and others, "Supplementary Magnetic Facilities for Photographic Sound Systems." *Society of Motion Picture and Television Engineers Journal*, Vol. 54, pp. 315–327; March. Methods to facilitate introduction of magnetic recording on 35-mm film; modifications for adapting photographic recording and reproducing systems so that they may be used alternatively for either photographic or magnetic recording; how existing transmission systems have been modified to include bias erase oscillator.

"Dialing in on Plant News; Transmitting Tape-Recorded Messages by Interplant Telephone." *Business Week*, p. 44+; November 18.

Franzine, T., and Musumeci, L., "Counting of Pulses Recorded on a Steel (Magnetic) Tape." *Nuovo Cimento*, Vol. 7, pp. 159–160; March (In Italian). Pulses are recorded with the tape moving with velocity $V_1$. When the pulses are counted the velocity is $V_2$. Experiments were carried out for $V_1 = 10\ V_2$. For a given percentage loss of pulses, the highest frequency which it is possible to record is then 10× the normal one of the counting apparatus.

Friend, A. W., "Adjustments for Obtaining Optimum Performance in Magnetic Records." *RCA Review*, Vol. 11, pp. 38–54; March. Theory indicates that in perfectly adjusted magnetic recording and reproducing system record medium should produce no even harmonics of single sine wave magnetizing signal which is applied to medium, if recording medium is initially in completely neutral magnetic condition; simple means are described for control and adjustment of magnetic recording system to approach this ideal performance.

——— "Magneto-Optic Transducers." *RCA Review*, Vol. 11, pp. 482–507; December. Some of the theoretical and experimental results obtained from evaluations of the magneto-optic effect as a means for producing an output voltage or current of instantaneous amplitude proportional to any applied magnetic potential, are described. The main objective was the development of a simple magneto-optic playback head for magnetic records. It is found that, with simple systems and presently available material, the maximum snr is only about 30 db. This is considerably below the minimum desired value. Various means for improving the snr are discussed. Other applications of the magneto-optic effect are suggested. A theoretical treatment of the system is developed so that the effect of proposed materials and variations of the system may be evaluated without difficulty.

Gallet, F., "Magnetic Sound Recording." *Onde Electrique*, Vol. 30, pp. 449–457; November (In French). Classifies magnetic sound recording under two headings: (a) where a nonmagnetic tape such as cellulose is coated with a magnetic powder, and (b) where the plastic tape is impregnated with magnetic powder before cooling. The action taking place during recording which is not fully understood is discussed and also the use of a polarizing field to avoid nonlinear distortion. DC polarization leads to excessive noise but the use of the supersonic ac polarization produces good results. The form of the recording and reproducing head is shown diagrammatically, also the form of the magnetization on the tape and the method of demagnetization. Stress is laid on the difficulty in making two recording heads giving exactly the same results on the tape, also the importance of having very high grade magnetic material to avoid noise. Response curves deviating $\gtrless 3$ db between 30 and 15,000 cps have been obtained.

Giltay, J., "(Hysteresis) Properties of Ferromagnetics." *Tijdschrift van het Nederlandsch Radiogenootschap*, Vol. 15, pp. 253–274; July–September (In Dutch). A general discussion of the geometry of hysteresis loops is given. Previous related work by Madelung (*Annalen der Physik*, Vol. 17, p. 865; 1905) is critically discussed. Application is made to magnetic sound recording.

Gould, K. G., and Falkner, R. I. T., "Application of Magnetic Recording to Sub-Standard Film Projectors." *British Kinematography*, Vol. 16, pp. 55–57; February. Advantages of magnetic recording in amateur motion picture work; description of Cine-Soundmaster magnetic tape recorder reproducer which can be mechanically coupled to mechanism of any projector and derives its motive power from projector drive through flexible coupling; data on tape characteristics and operation of equipment.

Grammelsdorff, F., and Guckenburg, W., "Methods for the Direct Frequency Linearization in the Reproducing-Head Circuit, of Magnetic-Tape Sound (Output)." *Funk und Ton*, Vol. 4, pp. 66–75 (In German). The relation between the inductance of the reproducing head and the emf induced in it is discussed and the effect on the low frequencies of connecting a capacitor in series with the reproducing head is considered. The use of variable resistance to

affect the frequency characteristic is also discussed. Inductance is used for correction of the higher frequencies. Formulas are derived for determining optimum values for the frequency-correction components. It is found possible to obtain a practically level frequency-response curve for widely different tape speeds. Results obtained experimentally confirm the theory.

Green, P. E., "Magnetic Tape Recorder for Very Low Frequency Phenomena." *Review of Scientific Instruments*, Vol. 21, pp. 893–95; November. An apparatus is described for the recording of electric signals of frequencies below 100 cps on magnetic tape for subsequent playback. A system of wide-deviation frequency modulation of an af carrier has been employed to eliminate the difficulties normally encountered in the direct recording of lf and cc signals.

Guckenburg, W., "Die Wechselbeziehungen zwischen Magnettonband und Ringkopf bei der Wiedergabe." *Funk und Ton*, Vol. 4, pp. 24–33; January. Demagnetization and finite-gap effect are primarily considered. An empirical exponential expression gives the reduction in output due to demagnetization for any particular type of tape, at any specified frequency in terms of $\lambda_1$, the wavelength at which the reduction is $e^{-1}$. Reduction due to the finite gap length is analogous to that caused by the slit effect in sound-film technique. Constant-current recording and negligible core losses are assumed. The limitations imposed on frequency range and tape-speed reduction are considered at length and it is indicated that tape with improved demagnetization characteristics is needed before a reduction of a gap-length below its present normal value can be of use.

Hare, D. G. C., and Fling, W. D., "Picture-Synchronous Magnetic Tape Recording." *Society of Motion Picture and Television Engineers Journal*, Vol. 54, pp. 554–66; May. Quarter-inch magnetic tape offers considerable economic and operational advantages for recording of sound track material; theory and basic design of system which provides completely adequate synchronization of sound with picture; various methods of automatically framing sound track and picture are considered; simple system capable of rapid framing described.

Hasselbach, W., *Die absolute Messung der remanenten Wechselinduktion auf Magnettonbändern*. Diplomarbeit Universität Frankfurt; 1950.

Hemardinquer, P., "Multiple Applications of Magnetic Recording." *Radio Française*, no. 6: pp. 8–16; June (In French). Some of these applications, apart from normal recording are described. They include: 1) use of an endless loop of wire or tape to interpose a short time interval between recording and reproduction. This device is useful in radio-diffusion where the interval permits suppression or modification of the original recording; 2) use of several reproducing heads located at specific points along the endless loop to correct for the different locations of several loudspeakers used simultaneously; 3) use of a similar set-up with attentuators in the lines from the heads to simulate the effect of reverberation; 4) a similar set-up with band-pass filters in each line, the outputs being subsequently brought to a common line to provide a speech-secrecy system; 5) use of two recording heads located at different radii on a magnetic disk to record short time intervals. Subsequent evaluation of the time interval can be effected with a stroboscopic disk drive from the turntable and two lights flashing at the start and finish of the interval; 6) recording of transients on an endless loop to facilitate subsequent study of a cro; (facsimile and other image recording). This technique is restricted to the max. frequency which can be transmitted. This, it is stated, is 20 kc for modern industrial apparatus.

Hildebrand, T. A., "Magnetic Tape Eraser." *Television Engineer*, Vol. 1, p. 21; June. Illustrated description of erasing unit built by engineers of station KMBY, Billings, Montana; unit is power transformer, with E and I laminations, rewound to provide magnetization charge and maximum erasure of signals on tape.

Hilker, R. R., "Remote Start Switch for Brush Recorder." *Tele-Tech*, Vol. 9, p. 43; September. A brief article describing a practical means of tape recording improving station operation.

Hust, L. B., "A Two Channel Magnetic Recording Amplifier." *Radio and Television News*, Vol. 44, pp. 45–47+; November. Panel view of home-built amplifier. It can be adapted for public address work.

Javitz, A. E., "Magnetic Recording Systems in Product Design." *Electrical Manufacturing*, Vol. 45, pp. 75–81, 186, 188, 190, 192, 194, 196, 198, 200, 202, 204; February. Review of major elements of typical magnetic recording system as follows: motor driven recording media; record, erase and reproduce heads; tape or wire transport unit; electronic circuit; some design case histories are included.

Jones, W. D., "And Now—Recorded Time Studies?" *Factory Management and Maintenance*, Vol. 108, p. 126; March. Describes a practical business application of the wire recorder.

Kolbe, O. K., "Magnetic Sound Film Developments in Great Britain." *Society of Motion Picture and Television Engineers Journal*, Vol. 55, pp. 496–508; November. Details and the general circuit arrangement of the apparatus are given, together with a description of special apparatus which has been used for adding a visible signal indication record to the invisible magnetic sound track. Apparatus which has been evolved for the bulk wiping of magnetic film stock is also described as well as experience gained with different types of magnetic film joints.

"Korea is Publicizing a New Interview Tool; Portable Tape Recorder." *Sales Management*, Vol. 65, pp. 84–85; October 1. "Mighty-Mouse," a highly portable tape recorder, is being put to wide use by radio reporters at the front. It was being groomed for market research interviewers and other commercial uses.

Lee, B. S., "Effects of Delayed Speech Feedback." *Acoustical Society of America Journal*, Vol. 22, pp. 824–826; November. Review of effects of letting person hear own voice by magnetic tape recorder device which feeds back reproduced speech to earphones about $\frac{1}{4}$ second or less after words are spoken; phenomenon of this delayed feedback as governor of speech speed and as causes of stuttering; speech mechanism model is portrayed which satisfies phenomena of natural speech, artificial stutter, and motor aphasias.

Lindsay, H. W., "Precision Magnetic Tape Recorder for High-fidelity Professional Use." *Electrical Manufacturing*, Vol. 46, pp. 134–139; October. Illustrated description of compact professional tape recorder developed by Ampex Electric Corp. to provide performance and reliability equal to that of more costly full frequency range broadcast type master model. Elec. Mfg. Product Design Award.

Lund, G. W., "Construction and Characteristics of a Non-Contact Electromagnetic Recording and Reproducing Head." PB 101986. 30p.; August.

"Machine Makes Record of Airway Reports." *American Business*, Vol. 20, p. 30; April.

"Magnetic Transducing Heads." *Electronic Engineering*, Vol. 22, p. 56; February. Description of head of type suitable for recording, reproducing, or erasing; advantages of using single head for all three functions, reducing size and cost of combination tape recorder-reproducer.

Mandl, M., "Quality Loss in Tape and Wire Recorders Due to Metallic Dust." *Radio and Television News*, Vol. 43, p. 70; February. Describes cleaning methods for tape and wire recorders.

Middleton, E. J., "Magnetic Recording and its Application in South African Broadcasting Corporation." *South African Institute of Electrical Engineers Transactions*, Vol. 41, pp. 41–51; Discussion, pp. 51–52; February. Paper outlines some of basic principles of and some of problems experienced in magnetic recording, and also indicates its principal advantages and disadvantages in broadcasting service; application of sound recording within South African Broadcasting Corp. is reviewed.

Miller, W. B., "Use of a Wire Recorder for Recording Geiger-Müller Pulses." *Science*, Vol. 111, pp. 626–627; June 9. Describes the use of the commercial wire recorder as an inexpensive method of solving certain recording problems in medical research.

"Multi-Lingual Announcement at Harwich." *Railway Gazette*, Vol. 93, pp. 240–241; September. To speed customs and immigration formalities and assist foreign visitors, recording multilingual announcements were introduced at Harwich, Parkeston Quay; announcements may be given in English, Dutch, Danish, and German; magnetic tape recordings used; tape speed is $7\frac{1}{2}$ inches per second; each announcement is given in English, Dutch, and German for main continental services and in English and Danish for Scandinavian service; method of operation; local recording; reduction of noise.

"Multi-lingual Announcing Equipment Installed at the Parkeston Quay Station of British Railways." *Engineering*, Vol. 170, p. 392; November 17. Describes installation of public-address equipment using magnetic tapes for announcing or recording.

"New Audio Trends." *Electronics*, Vol. 23, pp. 68–71; January. Recently exhibited electronic speed control system for magnetic tape records which provide lip synchronous playback accuracy for motion picture films and television transcriptions; new fluid for making magnetized tracks visible; portable shadowgraph for detecting

wear in phonograph needles; 78-rpm V-groove recordings going up to 20,000 cps.

Oerding, R., "A Contribution to the Problem of Noise in Magnetophone Sound Reproduction." *Funk und Ton*, Vol. 4, pp. 199–200 (In German). An analysis shows how the presence of even harmonic in the hf-bias waveform can lead to a dc component of magnetization in the tape and hence to an increase in noise. If the harmonic is not in phase with the fundamental and if a cubic relationship between magnetizing current and resulting flux is assumed, the dc flux component is shown to be $\alpha$ the (amplitude)$^3$ of the fundamental of the hf bias current. Four possible methods of reducing even harmonic content are: 1) compensation with an opposing dc current; 2) phase-shift adjustment of the hf bias harmonics; 3) inclusion of a resistance in the grid circuit of the oscillator tube to improve working symmetry; and 4) use of a push-pull oscillator. Of these the first three at least are sensitive to changes in type of tube or tape.

"Package Tune-Up Scotch Brand Sound Recording Tape." *Modern Packaging*, Vol. 24, pp. 108–109; December. Sales tempo quickens when features of recording-tape packages are brought into close harmony with consumer needs.

Pauly, W. W., "Studio Tape Recorder." *FM and Television*, Vol. 10, pp. 25–26; February. Presto Recording Corp. equipment described; unit, designated Presto SR-950, was designed to provide fast and accurate operation with minimum number of controls; tape system reels carry up to 5,200 feet; audio response is rated flat within 3 db from 50 to 15,000 cycles at tape speed of 15 inches per second, and 50 to 8,000 cycles at 7½ inches.

Pennsylvania University. Moore School of Electrical Engineering. *Functional Description of the EDVAC*. Vol. 1–2. Errata for Research Division Report 50-9. PB 110332. 8p.; November. Corrections made as of April 1, 1950.

"Plane-Tower Talk Tape-Recorded." *Aviation Week*, Vol. 52, p. 35; March 6; abstract *Safety Engineering*, Vol. 99, p. 34; April. Describes a new multi-channel magnetic tape recorder which stores for later reference all communications between control tower and plane.

"Practical Applications of Magnetic Recording—Tape and Film." *British Kinematography*, Vol. 17, pp. 182–188; December. Three part paper on magnetic recording in film production field; causes of apathy towards this method of recording, and possibilities it holds for effective application. Historical aspects, K. G. Gould; uses in feature film production, W. S. Dalby; uses in documentary film production, P. Birch.

Ranger, R. H., "Sprocketless Synchronous Magnetic Tape." *Society of Motion Picture and Television Engineers Journal*, Vol. 54, pp. 328–336; March. How advantage inherent in normally thin, narrow magnetic tape may be realized with new method of obtaining true synchronism with film for motion pictures; adaptability of system to dubbing and post synchronization is described; system offers wide frequency response and long playing time for television sound.

Rettinger, M., "Magnetic Record-Reproduce Head." *Society of Motion Picture and Television Engineers Journal*, Vol. 55, pp. 377–390; October. Description of RCA head of ring shaped type, known as Mi-10794, with emphasis on principles of construction; discussion of various lamination shapes for ring type heads, change of head inductance with change of front gap and back gap spacer thickness; lamination stacking factor as function of lamination thickness and other characteristics.

——— "Magnetic Recording in Motion Pictures." *Audio Engineering*, Vol. 34, pp. 9–12, 32–35; March; pp. 18–20, 42–43; April. Fundamentals of tape recording with particular reference to use of plastic tape with ferromagnetic coating. March: Advantages of magnetic recording as compared with optical methods; reproducing and erasing head construction. April: Frequency response of magnetic recording: effect of biasing; noise problems.

"Robot Announcer Keeps Supervisors Informed; Westinghouse Electric." *Mill and Factory*, Vol. 46, p. 102; June. Continuous tape recorder supplies up-to-the-minute company news.

Ryder, L. L., "Motion Picture Studio Use of Magnetic Recording." *Society of Motion Picture and Television Engineers Journal*, Vol. 55, pp. 605–612; December. Equipment and processes used in one particular film company are described. A production recording equipment using 17½-mm magnetic film weighs in all 100 pounds and consists of a recorder, a mixer, and a power unit. Facilities for monitoring and an announce-microphone with control button are provided. For the drive, batteries are used in the field and 1- or 3-phase supply in the studio. The recorder accommodates 2,500 feet of film.

Sano, K. M., "De Synchronisatie van de Magnetische Band met de Cinefilm." *Technisch-Wetenschappelijk Tijdschrift*, Vol. 12, pp. 282–284; December. Synchronizing magnetic tape with motion picture film; it is possible to synchronize magnetophone tape with motion picture film by printing appropriate synchronizing marks on back of tape, and then observing these in rotating mirror, connected either electrically or mechanically with projector or film apparatus.

Schuh, F., "La Précision Mécanique et l'Enregistrement Magnétique des Sons." *Revue Générale de Mécanique*, Vol. 34, pp. 259–261; July. Mechanical precision and magnetic recording of sounds; development since 1898; principle of magnetic recording; photographs, diagrams.

"Self-Threading Endless Tape Magazine, for Playback Machines Designed by Powell Announcer Corp." *Machine Design*, Vol. 22, pp. 108–109; June. Designed by Powell Announcer Corp. to facilitate the changing of recorded messages without the operator touching the magnetic tape itself. Diagrams included.

Selsted, W. T., "Synchronous Recording on ¼-inch Magnetic Tape." *Society of Motion Picture and Television Engineers Journal*, Vol. 55, pp. 279–284; September. Article discusses problem of synchronizing motion picture film with sound track on standard ¼-inch magnetic recording tape; equipment for synchronizing tape with film is dealt with particularly; use of standard Ampex Model 300 tape recorder; block and circuit diagrams.

"Seven Tape Recorders and a Wire Recorder Rate." *Consumers' Research Bulletin*, Vol. 25, pp. 15–17; January; p. 23; May. A brief discussion of price ranges on tape recorders and ratings on machines.

Shaney, A. C., *Elements of Single and Dual Track Magnetic Tape Recording and 1,001 Applications*. 2d ed. New York, Amplifier Corp. of America, 144 p., 1950.

"Sound Engineering for Quieter Automobiles." *Automotive Industries*, Vol. 103, pp. 52, 64, 66; November 1. Describes the use of a magnetic tape recorder in automotive acoustical research.

Southworth, G., "Dual-Input Tape Recorder Amplifier." *Radio and Television News*, Vol. 44, pp. 46–47, 114–115; October. Features high gain inputs, equalizer for 7.5-inch tape speed and outputs for monitoring and volume meter.

Speirs, B. H., "ABC Uses Magnetic Tape for Delayed Broadcasts." *Radio and Television News*, Vol. 43, pp. 41+; April. The exclusive use of magnetic tape in recording programs provides an inexpensive solution to delayed broadcast problem for ABC.

Suryan, G., "A New Method of Integration of Weak Nuclear Magnetic Resonance Signals." *Physical Reviews*, Vol. 80, p. 119; October 1. A high signal-to-noise ratio may be attained by using magnetic sound-recording apparatus.

"Tape Recorder Solves Mass Training Problem" (Abstract). *Sales Management*, Vol. 65, p. 74; November 20. Allen Electric's factory instructor records training story and 70 sales engineers carry it to mechanics' after-hours classes via portable recorders tied to visuals.

"Tape Records Tower Talk." *Aviation Week*, Vol. 53, p. 22; September 18. Brief description of Model 550-B Magnamaster produced by the Amplifier Corporation of America for recording plane-tower talk on a 24-hour basis.

Toll, J., "Art of Tape Recording." *Audio Engineering*, Vol. 34, pp. 13, 31–35; May; pp. 20–22, 43–45; June; pp. 22–23, 39–40; July; pp. 16–18, 29–31; August; pp. 15, 42–45; September. Practical aspects of magnetic tape recording and editing. May: history of tape recording; how recorder works. June: Factors making for good recording. July: Recording or "duffing" process. August: Methods of editing tape. September: Recording machine maintenance.

Toth, D. H., "High-Speed Writing and Selective Altering of Digital Information of Magnetic Surfaces." PB 101985. 22p.; September. Report covers an investigation of high-speed writing and selective altering of digital data on the magnetic surface of a rapidly rotating drum by utilizing hard vacuum tubes.

Vermeulen, R., and Westmijze, W. K., "The 'Expressor' System for Transmission of Music." *Philips Technical Review*, Vol. 11, pp. 281–290; April. In systems for sound transmission with a wide frequency band the difference between the level at which overloading starts and the level of the background noise is less than the difference that may occur in orchestral music between the loudest

passages and the noise in the concert hall, so that one is faced with necessity of applying compression in order to avoid both overloading and high background noise. In the reproduction of the music the original dynamic differences can be regained by means of expansion. It is claimed that adjustment of the compression by a capable hand has great advantages over automatic control. With nonautomatically adjusted compression, however, there is no unambiguous relation between the intensity of the original music and that of the input signal of the expandor always exactly compensates the compression. In the "Expressor" system a pilot signal causes the potentiometer of the expandor to follow continuously the movements of the compressor. This pilot signal is transmitted via a separate channel and may consist, for instance, of impulses. If Philips-Miller tape is used as a sound record the pilot signal can be registered on the same tape in two pilot tracks (one for each direction of rotation of the compressor).

Vieth, L., and Henning, H. A., "Magnetic Recording and Reproducing of Sound." *Electrical Engineers' Handbook*. Part 2: Electrical Communication and Electronics. 4th ed. New York, John Wiley and Sons. Pp. 13–28, 13–37; 1950. A brief summary of the subject including a bibliography. Arrangements, processes, and recording media are discussed.

Weber, K. H. R., "Analysis of a Spectrum of Very Low Frequencies by Means of Magnetic Tone-Frequency Equipment." *Funk und Ton*, Vol. 4, pp. 619–627; December (In German). Periodic variations of modulation frequency in the range 1–300 cps are recorded on the magnetic tape of a recorder connected to a tone-variation meter. The tape speed is 1/30 of the normal speed at 77 cm so that when run in the reproducing equipment at the normal speed, the frequency range becomes 30–9,000 cps. A general description is given of the analyzing equipment, with a circuit diagram of the recorder and a short account of auxiliary equipment, including an electromechanical tone-frequency generator with ranges of 0.8–12 cps and 8–120 cps.

Werner, P. H., "Tests on Magnetic Tapes Intended for Operation at 15 in/sec." *Technische Mitteilungen PTT.*, Bern, Vol. 28, pp. 382–388; October (In French). These tests, carried out on five types of tape, were intended to establish, not only their suitability for 15 inches per second operation, but also the degree of interchangeability between them.

"Why 600 Minnesota Schools Now Use Recorders as Teaching Aids; Minnesota Mining and Manufacturing Co. Recording Tape." *Sales Management*, Vol. 64, pp. 112, 114, 116–117; January 15. It's all the doing of Minnesota Mining and Manufacturing Co. The company's interest; a bigger market for tape. The program has been on a low-pressure basis with 3M merely revealing some unexploited teaching opportunities.

Zenner, R. E., "Magnetic Recording of Meter Data." *Audio Engineering*, Vol. 34, pp. 16–17, 33; February. How recording equipment normally employed for sound may be used to advantage in various types of instrumentation; such recording is often desired because of its ability to change time scales by recording at one speed and playing back at another, or because of other advantages; accuracy of recording media; types of recording applicable; spurious response problems.

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Andrews, D. R., "Broadcast Tape Speed Control." *Electronics*, Vol. 24, pp. 120–123; July. Playback time of tape recorded programs may be adversely affected by climatic changes; method whereby magnetic tape programs can be played back within less than 1 second of original half hour recording time despite 2 per cent stretch or shrink; use of printed bars on back of tape which are scanned photoelectrically to produce comparison signal that is held at exactly 60 cps.

Anker-Rasmussen, S., "New Danish Playback Machine." *Audio Engineering*, Vol. 35, pp. 40–43; September. Features of "Telifon" tape recorder in which recording medium is endless polyvinyl chloride tape with 56 parallel sound tracks spaced at ordinary rate of four tracks per mm; hardness of plastic tape in conjunction with almost complete freedom from grain ensure high quality of reproduction; 90-minute playing time possible.

Bierl, R., "Über den wahren Frequenz gang bei der Aufnahme und Wiedergabe nach dem Magnettonverfahren." *Zeitschrift für Angewandte Physik*, Vol. 3, pp. 161–165. When the well-known theory and analysis, derived for sound film and based on a rectangular gap, are applied to magnetic recording, discrepancies as regards fall-off of top response appear. These have previously been attributed to demagnetization effects. As an alternative, a solution based on the assumption of an exponential tap is studied and the spatial flux distribution over both recording and playback heads derived. The resulting intensity of magnetization in the tape falls off with increasing frequency and the frequency response of the playback head, plotted as (emf output) frequency vs frequency, shows a falling-off both at the top and in the bass. The effect of the input circuit to which the playback head is connected is also considered, the influence of loading discussed, and expressions derived for the output voltage in terms of all the head and input-circuit parameters. The resulting frequency characteristics, theoretically derived agree sensible with experimental results without admitting possible demagnetization effects as well. The requirements of tapes used for testing playback circuits are discussed.

Blake, W. R., "Wire Recorders in Making Inventories for PPF Risks." *Eastern Underwriter*, Vol. 52, p. 20; September 7.

Clarence, N. D., and Malan, D. J., "Magnetic-Tape Recording of Electrostatic Field Changes." *Physical Society of London Proceedings*, Vol. 64B, p. 529; June 1. The 1,200 cps output from the fluxmeter is first fed through a preamplifier and then in parallel to a commercial type magnetic-tape recorder and an oscilloscope. By means of the latter, the output of the fluxmeter may be checked visually.

Crane, G. R. and others, "Professional Magnetic-Recording Systems for Use with 35-, 17½- and 16-mm Film." *Society of Motion Picture and Television Engineers Journal*, Vol. 56, pp. 295–309; March. Portable recording system for producing high quality sound track in synchronism with pictures was designed to enable magnetic ecording to conform with standard motion picture studio operating practices; features are high speed rewind interlocked switching facilities, one basic type of amplifier and use of miniature tubes throughout.

Daniel, E. D., and Axon, P. E., "Accidental Printing in Magnetic Recording." *B.B.C. Quarterly*, Vol. 5, pp. 241–256; Winter. This effect is observed when tape with strong recorded signals is wound up in a normal reel, the printing taking place immediately above and below the strong-signal position. An analysis of the effect is given, one simplifying assumption being that the permeability of the slave tape = 1 at the low magnetizing levels prevailing. Max. transfer is shown to occur when the wavelength $\lambda = 2\pi d$, $d$ being the distance between tape centers. Easy methods of testing are described. The print intensity, like that of unbiased signals generally, will fall by 10 db in as many minutes when the master tape is removed, although the drop for a normal signal recorded with hf bias is $\geq$0.2 db over long periods. Print intensity increases with storage time and becomes more stable. It rises linearly with the level of the master and increases $\sim$7 db for a temp. rise of 20°C. The fall-off of print level per lay is $\sim$4 db. Some alleviation of the effect, it is felt, could be achieved by the use of hf partial erasure during replay.

Duchateau, F., "L'Enregistrement Magnetique du Son." *Courants Faibles, Electronique*, no. 11, pp. 303–312. Magnetic sound recording; review of various factors involved in magnetic recording, including those affecting response curve, dynamic range, erasing, noise, and crosstalk; principal application.

Eidson, H. G., "Tricks in Tape Recording." *Television Engineering*, Vol. 2, pp. 14, 16, 28–29; March. Examples of practices at station WIS with tape recording equipment, flexibility of which permits ready processing of variety of effects through splicing, dubbing, and speed control; particular reference made to station's dubbing setup with one echo-chamber speaker and regenerating type recorder which enables unusual effects to be produced; block diagram.

Enkel, F., "A Contribution to the Lubrication of Magnetophon Moving Parts." *Tech. Hausmitt. NordwDtsch Rdfunks*, Vol. 3, pp. 84–87; May (In German).

"Four-Way Brake Controls Recorder." *Machine Design*, Vol. 23, pp. 125–126; July. Describes and diagrams an ingenious braking system on the Webster Chicago model 288 wire recorder.

Fowler, C., "Profit in Tape." *FM and Television*, Vol. 11, p. 35, August. Five important advantages of tape over disks for sound recording; types of tape machines available and present market for such equipment; recent trends in tape field.

Gallagher, R. L., "Tape Recorder Echo Chamber." *Tele-Tech*, Vol. 10, p. 46; September. A procedure was evolved which uses a tape recorder with three heads allowing recording and subsequent pick-up off the tape as completely separate operation. The effect

achieved by this use of controlled reverberation produces a more "live" effect.

Giltay, J., "On Ferromagnetic States." *Applied Scientific Research*, Vol. B2, pp. 199–216. English translation of an article reported in *Tijdschrift van het Nederlandsch Radiogenootschap*, Vol. 15, pp. 253–274; July–September, 1950.

Gondesen, K. E., "A New Battery-Driven Magnetophon Equipment, R64 and R65." *Tech. Hausmitt. NordwDtsch Rdfunks*, Vol. 3, pp. 180–184; October–November (In German). Two successive designs representing improvements over the existing mobile model but still driven from a 12 v battery, are described. The first, the R64, of which a complete specification is given, operates at 30 inches per second, accommodates 750 m of tape, permits earphone-monitoring during recording and is provided with hf bias and erasure. One 4-pole motor alone is provided and, by means of belt drives, permits fast forward and back rewind. It is also fitted with slip-rings to act as a rotary convertor and provide a 50 cps supply which, after transforming and rectifying, forms the ht supply. A centrifugal contact regulator maintains constant speed. A small ht battery provides anode current when the motor is not running. The somewhat complicated equalizing networks in the amplifiers are described in detail. The whole instrument is housed in a wooden cabinet. In the later design, the R65, the capstan drive is altered and the rewind speed increased. The single motor is now a combined motor and motor-generator providing 250 v dc direct, thereby facilitating the elimination of ripple and improving speed control because of lower contact current and higher voltage.

——— "The New Interval-Indicating Machine B-R 40." *Ibid.*, pp. 184–185 (In German). This instrument, employed in broadcast stations, uses magnetic-recording technique like its predecessor the B-R 29. A 285 cm continuous loop of tape, embodying a thickened portion 5 cm long, runs at 38 cm/second. The single playback head feeds into a standard playback amplifier and there are several controlling relays. The drive includes a single motor, a rubber capstan, a feeler contact on the tape and a mechanical filter. The motor is started up by any convenient remote control and when the thickened portion of tape passes over the feeler contact, the movement of the latter initiates relay operation. One relay connects the playback amplifier across the modulation line into which signals from the active portion of the tape, corresponding to 7.2 seconds duration, now pass. Another relay switches on indicating lights. A complete cycle of operations is repeated once for each other rotation of the loop. On switching off, the motor continues to run through relay action until a cycle is completed. Improvements over the earlier design are: quicker starting and stopping, higher snr and greater active tape length on a shorter length of loop.

——— "Repetition Apparatus for the Amplified Reproduction of Distortion." *Ibid.*, pp. 83–84; May (In German). Description of apparatus for distortion tests of the type that uses a tape recorder to magnify the distortion of a signal by repeated transmission around a loop circuit.

Goodell, J. D., "Past, Present and Future Recording Systems." *Radio and Television News* (Radio-Electronic Engineering Edition), Vol. 16, pp. 11A–13A, 27A; May. Review of concepts that may lead to development of recording systems superior to those available at present and discussion of characteristics and limitations of known methods; four basic recording mediums and systems considered include physical, chemical, magnetic, and electrostatic methods; recording as applied to computers.

"Graph Proves Quality Goes with Package of Audiotape." *Industrial Marketing*, Vol. 36, pp. 34–35; October.

Green, H. E., "How a Small Company Stays on Top of Shifting Markets: Magnecord, Inc." *Printers' Ink*, Vol. 235, pp. 25–27; May 18. A story of sound advertising and sales strategy.

Hemardinquer, P., "Le Ruban Magnétique et ses Applications." *Electricité*, Vol. 35, pp. 298–304; December. Magnetic tape and its applications; review of principles of magnetic recording on tapes and physical properties of tapes; operational features of tape recorders and playbacks; applications for sound recording, stereophonic reproduction, acoustical studies and various control and measurement instruments.

Herr, R., "Mixed Ferrites for Recording Heads." *Electronics*, Vol. 24, pp. 124–125; April. With increasing frequency, inability to stand wear and high eddy-current losses even with the thinnest practicable laminations sets a limit to the use of high-permeability ($h\mu$) alloys. By contrast, certain ferrites, *e.g.*, $ZnO \cdot Fe_2O_3 \cdot MnO \cdot Fe_2O_3$, which have permeabilities comparable with the $h\mu$ alloys at room temperature are harder than the normal tape coating and have sufficiently high resistivities to make eddy-current losses undetectable below 1–30 mc. Heads made up with Ferramic E show best results on playback because of the high initial $\mu$ while Ferramic G is preferable for record and erase heads because of high resistivity. Such heads are generally easier to construct than laminated ones, but they require careful lapping around the gap owing to the hardness and coarse grain structure. This coarseness which is not necessarily inevitable, tends to reduce sensitivity at short wavelengths. The materials show a lower tendency towards permanent magnetism and higher temp. coeff. than $h\mu$ alloys. Their usage may spread because of their relatively low percentage content of scarce metals.

Heyer, H., "Box-Construction for Magnetophon Installations." *Tech. Hausmitt. NordwDtsch Rdfunks*, Vol. 3, pp. 141–145; September (In German). A new design for these equipments, when intended for broadcast studios, is described. All-metal cabinets are employed and most of the units are made to slide in. An installation embodies two types of cabinet, one containing the drive unit on top and the head amplifiers below, the other housing control equipment such as relays, output meters, etc., and the power amplifiers. The drive unit rests on rails which in turn are spring-supported from the cabinet frame. Al is used where it will help to reduce magnetic fields. A normal installation consists of two drive units with a power unit located between them. Accordingly, the wiring of the drive unit is so arranged that it can be readily connected up to a power and either on its left or its right. The new form of construction lends itself to easy handling, economical assembly and accessibility for testing.

Hilliard, J. K., "Survey of European Sound Apparatus." *Audio Engineering*, Vol. 35, p. 32; August. Results of 10-country survey made by author on behalf of Altec Lansing Corporation; European economy has not yet favored music systems comparable in quality to those available in United States; phonograph reproduction is principally with 78 rpm records; crystal and earlier type magnetic pickups are in common use; often different standards prevent uniform product design in different countries.

"How to Read Everything; Cole Electric Co. Executives Get Daily Tape-Recorded Digest." *Business Week*, p. 105; August 18.

"How to Sell Sound; Prospects for Donaldson's Engine Mufflers Hear Tape Recordings." *Sales Management*, Vol. 66, p. 45; June 1.

Hust, L. B., "Adapt Your Amplifier for Magnetic Recording." *Radio and Television News*, Vol. 45, pp. 64–65+; May. Construction details on an ultrasonic oscillator that can be used with your audio amplifier for recording and erasing on magnetic tape or wire.

——— "Combination Phonograph-Tape Recorder." *Radio and Television News*, Vol. 46, pp. 43–46, 102, 104; November. All parts are either readily obtainable or can be home built without special tools or equipment.

Ledbetter, R. P., "Tape Editing and Duplicating Machine." *Audio Engineering*, Vol. 35, pp. 18–20, 44–45; December. Details of system arranged for flexibility of operation in studio where recording, playback copying, and duplicating are regular procedures; tape mechanisms are high quality, rack mounted units, each with self contained bias oscillator; three types of amplifier units used; record playback, duplicating, and cuing details of other components and equipment operation; block and circuit diagrams.

Lewin, G., "Special Techniques in Magnetic Recording for Motion Picture Production." *Society of Motion Picture and Television Engineers Journal*, Vol. 56, pp. 653–663; June. Method of stopping and reversing recorder and projector without losing synchronism and changing over from "Record" to "Playback," or vice versa, silently, while running; procedures described make it possible to correct errors in narration and re-recording jobs without need for rethreading, splicing or blooping film; new method for domestic and foreign lip synchronous production.

——— "Synchronous ¼-inch Magnetic Tape for Motion Picture Production." *Society of Motion Picture and Television Engineers Journal*, Vol. 56, pp. 664–671; June. How with proper modifications of existing commercial equipment, ¼-inch tape can be made to do practically everything possible with 35-mm sprocketed magnetic film in various stages of motion picture production; savings in cost and storage space can be more than 90 per cent; new technique is equally valuable for producing motion pictures for television.

Lowden, R. W., "Recording on Tape." *Wireless World*, Vol. 57, pp. 283–285; July. Prevalent causes of poor results due to faulty de-

sign of recorder; methods of reducing hum, wow, and flutter by proper design; use of two separate channels for recording and playback operations to avoid complicated switching circuits; choice of suitable recording characteristics.

"Magnetic Dictation Machine." *Electrical Review (London)*, Vol. 148; p. 683; April 6. News item describing Belgian machine.

"Magnetic Tape Recording." *Fortune*, Vol. 43, pp. 97–100, 102, 104, 106; January. Radio, movies, and even phonograph-record companies now swear by it. Magnetic tape may also carry a message for nearly every businessman. Traces the development of magnetic recording.

Masterson, E. E., "Magnetic Sound on 16-mm Edge-Coated Film." *Society of Motion Picture and Television Engineers Journal*, Vol. 57, pp. 559–566; December. Description of small head for magnetic recording and reproduction developed to fit within area of sound drum of standard RCA-400, projector; head mounting is such that projector can be used for two magnetic functions as well as photographic reproduction; amplifier modifications include increasing gain, using compensating circuits, decreasing oscillator distortion, etc.; circuit diagram.

"Measuring and Recording Muffler Efficiency." *Automotive Industries*, Vol. 104, pp. 52+; May 15. Describes the adoption of magnetic tape recording to a method of muffler analysis.

Meyer-Eppler, W., "The Measurement of Very Small Attenuation and Phase Distortions and Methods of Making Them Audible." *Tech. Hausmitt. NordwDtsch Rdfunks*, Vol. 3, pp. 77–80; May (In German). Describes the use of a tape recorder to magnify the distortion of a signal by repeated transmission around a loop circuit.

Montgomery, J. R., "Tape Transport Theory and Speed Control." *Society of Motion Picture and Television Engineers Journal*, Vol. 57, pp. 63–68; July. Absolute speed control can be achieved only with fixed or recorded reference; factors involved are physical properties of tape and of tape transport; if tape properties can be accepted as they exist, mechanical theories of tape transport must be investigated; résumé of pertinent and little understood phenomena of tape transport; limits which theories have achieved in practice.

"Modern Plastics in Tape Recorder." *Modern Plastics*, Vol. 28, p. 80; April. Magnetic tape recorders are using plastic materials in increasing amounts and in new ways.

Muckenhirn, O. W., "Recording Demagnetization in Magnetic Tape Recording." PROCEEDINGS OF THE IRE, Vol. 39, pp. 891–897; August. Analysis of recording process employing supersonic excitation; study of effect of spatial distribution of magnetic field around recording head air gap on magnetic history of unmagnetized element of tape as it tracks across recording head, leads to effect termed "recording demagnetization" and serves to explain certain performance characteristics.

Oerding, R., "The Process of Magnetic Sound Recording." *Funk und Ton*, Vol. 5, pp. 262–270; May; pp. 297–299; June. Also in *Tech. Hausmitt. NordwDtsch Rdfunks*, Vol. 3, pp. 104–109; June (In German). A review of present knowledge. A brief description is given of an arrangement for taking the hysteresis loops of recording tape. The influence upon these of the composite nature of the magnetic path in practice is dealt with. It is shown that a self-demagnetizing field occurs whose magnitude depends on the induction in a strictly linear manner and on frequency somewhat exponentially. It is then demonstrated how the tape sensitivity for lf depends on the remanence and for hf on the coercive force. Starting from the hysteresis loop the graphical construction of the remanence, transfer, and differential characteristics is explained and the relations among them brought out. With the aid of these the essential process is examined and it is shown the hf biasing can be considered as a combination of the 3 fundamental principles; use of bias to attain favorable operating point, the push-pull principle, pulse-multiplex transmission. The second part deals with the operation of the sound and erasing heads. It is shown that the amplitude-effective gap-width of the input head depends on the shape of the decay line in the field-distribution curve and unlike the reproducing head, is independent of the geometric gap. The effective gap in the input head is normally so small that in effect can be neglected over the useful range of frequencies.

Peterson, E. S., "Automatic Time Announcer." *Automatic Electric Technical Journal*, Vol. 2, pp. 148–153; January. Previous telephone time announcing techniques; requirements to be met by automatic time announcer; description of Automatic Electric Co.'s automatic time announcer which utilizes magnetic tape recording technique; functions and operation of master clock; provision made for commercial announcements; power supply and controls.

"Proposed American Standard; Dimensions for Magnetic Sound Tracks on 35-mm and 17½-mm Motion Picture Film; on 16-mm and on 8-mm Film." *Society of Motion Picture and Television Engineers Journal*, Vol. 57, pp. 72–74; July. Proposed standards Ph 22.86, Ph 22.87, Ph 22.88.

Puhlmann, W., "Über die magnetischen Vorgänge in Tonträgern und Magnetköpfen von Magnettongeräten." *Funk und Ton*, Vol. 5; pp. 65–75; February. Magnetic process in magnetic tapes and magnet heads in magnetic sound equipment; discussion of magnetic properties of powdered materials in sound tapes with particular reference to high frequency characteristics; demagnetization process in powder particles; analysis of field produced by magnet head; noise produced by magnetic particles.

Rettinger, M., "A-C Magnetic Erase Heads." *Society of Motion Picture and Television Engineers Journal*, Vol. 56, pp. 407–410; April. Various types of erase heads of ring shaped type described; mathematical treatment of magnetic flux density required for erasing; measurements of amount of erasure obtained from various heads used both singly and in cascade; curves show rise in temperature on part of two heads as function of 70 kc erase current through head.

Schmidbauer, O., "Magnetophon-Messtechnik." *Fortschritte der Radiotechnik*, Vol. 12, pp. 193–205; (Issue no. 3). The simpler technique for setting up the reproduction side only is first described. A signal is introduced into the pick-up circuit from an af generator either directly or by induction from a coil into the head itself and the frequency characteristic of the reproducing amplifier checked. A standard tape should preferably be available for setting levels. The procedure for orientation of the gaps and the investigation and reduction of mains hum are also described. Calibration of the recording side as well calls for checks on the level of the hf bias relative to the af signal, determination of the correct operating point for sensitivity and amplitude and of the 3rd-harmonic content. Precautions to be taken when checking the overall characteristic include avoidance of overloading and on hf bias in the reproducing head. Adjustment for nonstandard heads and for tapes of different sensitivity, the detection and elimination of head magnetization, and the correction of asymmetrical bias waveform are discussed. The frequent desirability of "mass" erasure by means of a strong ac-mains field or the discharge of a hv capacitor through a coil is stressed. The factors affecting "transfer" and the difficulties attending its measurement are also discussed. A complete list of test equipment required is appended.

——— "Vervielfältigung von Magnetophon-Aufzeichnungen." *Ibid*, Vol. 12, pp. 326–329 (Issue no. 4). Playback methods are first considered and their limits stressed. The "copy-effect" is then described. If a processed and a blank tape are placed in intimate contact and subjected to a common fairly weak field, the recording may be transferred. An arrangement is described in which three daughter tapes run in contact with the mother at different points under copying heads fed with current at 1 kc. It is necessary to use a high-coercivity mother and low-coercivity daughters. A graph is shown of the frequency characteristic of the copy from a linear tape at 38 cm. This may be overcome by pre-emphasis in the mother recording. It is stated that this method is also applicable to disk-type magnetic recordings. In all cases, however, it is to be noted that the reproduction is a mirror-image of the original and suitable precautions must be taken on that account.

Schurch, E. C., and Schleif, F. R., "A Magnetic Tape Oscillograph for Power System Analysis." *Electrical Engineering*, Vol. 70, pp. 993–997; November. Also in *American Institute of Electrical Engineers Transactions*, Vol. 70, pp. 1296–1300. An investigation of the magnetic recording technique for the purpose of obtaining automatic records of power system phenomena.

Spratt, H. G. M., "Magnetic Recording Tape." *Wireless World*, Vol. 57, pp. 88–91; March; pp. 149–151; April. Characteristics of magnetic tapes and advantages arising from recent developments. March: Basic frequency characteristics of tapes; description of magnetization process taking place in coated materials. April: Demagnetizing effect of elemental particles on frequency characteristics of tape; effects of change of magnetic properties of coating; noise properties of tape; transfer by magnetic induction to adjoining layers; low, medium, and high coercivity coatings.

Steinbuch, K., and Dolz, H., "A New Magnetic Tape Exchange-Announcing Equipment." *Fernmeldetechnische Zeitschrift*, Vol. 4, pp. 121–123; March (In German). This equipment is intended for installation at exchanges in the subscribers' trunk dialing network to identify the relevant intermediate exchanges during the setting up of a call and thus to facilitate the latter process. The

equipment is contained in a single mains-operated panel 392×196×300 mm deep, and comprises a single turn of magnetic tape wrapped round a large wheel drive at ½ rev. per second by a synchronous motor, together with a pickup head and a 2-stage amplifier giving a normal output of 1.5 volt from a 3Ω impedance. Preliminary life-tests indicate high reliability.

Stewart, W. E., "New Professional Tape Recorder." *Audio Engineering*, Vol. 35, pp. 21–23, 36–37; April. Particulars of RCA's professional tape recorder featuring remote control of operation which especially suits it to broadcast station use; unit, designated RT-11A, consists of four major parts: tape handling mechanism, power supply, recording amplifiers, and reproducing amplifier; design affords accurate timing, low wow and flutter, plus quick starting with push button control; circuit diagrams.

"Tape Recorder; Multichannel Aircraft Communications Two-Way Recording System." *Aviation Week*, Vol. 54, pp. 69–70; March 26. News item.

Ulner, M., "German Magnetic Sound Recording System in Motion Pictures." *Society of Motion Picture and Television Engineers Journal*, Vol. 56, pp. 411–422; April. Equipment developed at Film-studio Tempelhof of Universum Film A G (formerly UFA) is described; contrary to American and British practice starting point was to employ magnetic sound technique in studio until final re-recording on sound negative film; system is not based on optical sound recording and retains 6.5-mm magnetic tape for original recordings because of its economy.

Wallace, R. L., "Reproduction of Magnetically Recorded Signals." *Bell System Technical Journal*, Vol. 30, pp. 1145–1173; October. Introducing spacing between reproducing head and recording medium decreases reproduced voltage by number of db; for short wavelengths loss is many db even when effective spacing is only few ten thousandths of inch; it is argued that imperfect magnetic contact between reproducing head and recording medium may account for much of hf loss observed in speech studies.

Werner, P. H., "A New Method of Measuring the Speed of Magnetic Tape." *Technische Mitteilungen PTT*, Vol. 29, pp. 390–392; October. Ignoring mains-frequency variations, tape speeds may vary owing to slip at the capstan drive or wear of the capstan wheel. A well-known laboratory method of checking such variations is to record on the tape square waves of the frequency used for the drive, *i.e.* 50 cps. Then, if the tape is dipped in a liquid which evaporates rapidly and holds iron powder in suspension, the number of wavelengths $N$ is a specific length of tape 1 can be visibly counted to an accuracy better than 1 per cent. The tape speed at any nominal frequency is then $1/N \times f$, regardless of the actual frequency used. For rapid studio testing a differential gear train is employed, the common wheel of which drives a counter. One differential is driven by a motor fed from the mains supply, the other by another motor fed from the amplified output of the recorder under test. The tape used is one on which has been recorded a signal which is exactly 50 cps at the correct tape speed. The reading of the counter taken over a specific time is a measure of the deviation of the speed from its correct value.

Wight, V. "KFAB's Magnecorder Modifications." *Tele-Tech*, Vol. 10, p. 37; June. Specific requirements of radio station KFAB call for some modification of popular Magnecord PT6-JA tape recorder.

Yarnes, D. C., "New Editing Machine for Professional Tape Recordings." *Tele-Tech*, Vol. 10, pp. 32–33, 58–59; January. Description of RCA-NBC instrument designed to facilitate editing and play back of magnetic tape recordings through high quality audio reproducing system and to provide rapid, yet simple means of spotting, marking, cutting and splicing tape; rewinding and stopping features; control system; method of marking tape.

Zenner, R. E., "Magnetic Recording with AC Bias." PROCEEDINGS OF THE IRE, Vol. 39, pp. 141–146; February. Function of ac bias in magnetic recording is analyzed in manner similar to that used to explain amplitude modulation; simplifying assumptions made to facilitate manipulation of mathematical expressions; analytical results compared with experimental observations of harmonic distortion, amplitude of fundamental, spurious recorded frequencies, frequency response, difficulty of erasure and other properties.

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Aldous, D. W., "Duplicating Tape Recordings." *Wireless World*, Vol. 58, p. 320; August. New American system for quantity reproduction of magnetic tapes; common mandrel is used to drive master and several slave tapes, enabling accuracy of length in reproduced tapes better than one inch in 1,200 feet.

Axon, P. E., "Investigation Into Mechanism of Magnetic-Tape Recording." *Institution of Electrical Engineers Proceedings*, Vol. 99, Part 3 (Radio and Communication Engineering) pp. 109–124, Discussion, pp. 124–126; May. Intensity variation in tape passing through recording tap forms part of series of unclosed and markedly asymmetrical hysteresis loops; effect of asymmetry gives distinctive properties to recording and distortion characteristics of unbiased recording; gap length of recording head is critical and leads to occurrence of maxima and minima of recorded level and distortion at specific wavelengths.

Berlant, E., "New Tape Recorder has Many Features." *Radio and Television News*, Vol. 48, pp. 48–49+; November. Self-activating disk brakes and improved bias oscillator are among the many features of this new professional tape recorder unit.

Boothe, K. B., "Tape Recording for Telemetry and Data Analysis." *Tele-Tech*, Vol. 11, pp. 44–46, 116; May; pp. 56–57, 90, 92, 94; June. How development of extended range magnetic tape recorders gave rise to new field of tape recording for instrumentation and data analysis; special purpose recorders using multitrack tapes find applications in studies of guided missiles, aircraft and vehicular operation, shock and vibration tests and computers; recent innovations which sharply reduce wow and flutter.

Camras, Marvin, "New Magnetic-Recording Head." *Society of Motion Picture and Television Engineers Journal*, Vol. 58, pp. 61–66; January. A 3-pole magnetic head produces a magnetic field at the recording gap which is more uniform throughout the thickness of the magnetizable layer, and decays more rapidly at the trailing edge. With this head, optimum bias is practically the same for high as for low af. High af is recorded at a 3 db to 7 db higher output level before distortion as compared with a similar head of conventional design.

Carey, L. I., and Moran, F., "Push-Pull Direct-Positive Recording—Auxiliary to Magnetic Recording." *Ibid*, pp. 67–70. Explanation of method of transferring magnetic film from daily "okayed" production takes to push-pull direct positive film; by using protective coating on sound track, cutting room hazards are reduced 90 per cent; this coating can be "peeled off" just before dubbing, assuring new clean track from which to dub.

"Combined Insurance Co. of America Features Sales Training on Tape Recorders." *Eastern Underwriter*, Vol. 53, pp. 26–27; July 4.

Daniels, H. L., "Boundary-Displacement Magnetic Recording." *Electronics*, Vol. 25, pp. 116–120; April. New method of magnetic tape and drum recording analogous to variable area sound on film recording; how problem of intensity nonlinearity is met by producing magnetic record such that continuous range of magnetization is not involved; tape is magnetized to saturation at all times; unmagnetized boundary weaves back and forth according to signal waveform.

Davis, C. C. and others, "Multichannel Magnetic Film Recording and Reproducing Unit." *Society of Motion Picture and Television Engineers Journal*, Vol. 58, pp. 105–118; February. The unit provides three 200-mil tracks in accordance with a proposed ASA standard for 35-mm film. The effective crosstalk between adjacent tracks approximates −60 db and flutter content does not exceed 0.05 per cent. Complete recording and reproducing transmission equipment is housed in the recorder and associated base cabinet. The recording channels operate from a nominal input level of −30 dbm, and a reproduced output of 16 dbm is obtained from each of the reproducing channels.

Del Valle, G. A., and Putzrath, F. L., "Optical-Magnetic Sound 16 mm Projector." *Ibid*. Vol. 58, pp. 312–322; April. The instrument described has been designed to record, reproduce, and erase magnetic sound track as well as to reproduce photographic sound track of 16-mm film.

DeWitt, C. C. and others, "Pigment-Grade Iron Oxides-Recovery from Iron-Containing Waste Liquors." *Industrial and Engineering Chemistry*, Vol. 44, pp. 673–678; March. Describes a pilot plant for the wet process chemical production of synthetic pigment grade iron oxide. Magnetic recording tape represents one currently well-known and recent application of specification grade iron oxides.

Didier, A., "The Use of Paper as a Support in Magnetic Tape Recording." *Association Technique de l'Industrie Papeterie Bulletin*, Vol. 6, pp. 27–30. A brief historical review is followed by suggestions regarding the characteristic properties of suitable supports (I) for magnetic oxides of Fe with which they are coated or impregnated. Kraft papers of a special type function very well as I, because of their high tensile strength, slight elongation, uniform thickness, and slight linear expansion or contraction with changes in humidity

and temperature. Certain of these properties are compared with those of such plastics as cellulose acetate and polyvinyl chloride.

Dolan, K. J., "Presetting a Tape for Broadcasting." *Electronics*, Vol. 25, pp. 196, 200; April. Describes how a small radio station such as WARA (Attleboro, Mass.) can operate a tape recording to be used for broadcasting by a remote control switch.

Endall, R., "Magnetic Tape-Recording System." *Radio-Electronic Engineering*, Vol. 30, pp. 3–6, 30; March. Such system has the following advantages: 1) compactness as regards storage of information and size of equipment; 2) low cost both initially and in operation; 3) indefinite facility for repeated playbacks and erasure; and 4) ease of multi-channel recording. Multi-channel operation is effected by either time-division, frequency-division, or space-division methods. The time-division technique can be subdivided into the usual pulse-amplitude, pulse-time, pulse-width, and pulse-code modulation for all of which mechanical or electronic commutators are necessary. Frequency-division systems embody several sub-carrier oscillators of different frequencies, amplitude- or frequency-modulated by the signals to be recorded. FM is favored, particularly for recording signals above 16 kc to avoid hf amplitude changes but either great emotional stability is required or else the complication of electronic compensation by the addition of an unmodulated carrier must be accepted. For recording signals which include dc components the use of frequency-modulated carriers is recommended with multi-track systems. Photographs of several multi-channel equipments are shown.

"Finds New Use for Recorder; Benedict Kruse Uses Wire Recorder to Record Picture and Story Ideas while Driving between Assignments." *American Business*, Vol. 22, p. 43; June.

Gallet, F., "Progrès et Tendances de l'Enregistrement Magnétique à Haute Fidélité." *Onde Electrique*, Vol. 32, pp. 295–301; July. The effect of variation in hf-bias level on the amount of output distortion is discussed, and compared with low- and high-coercivity tapes. The slow rate of increase of distortion with output as compared with that of amplifiers is emphasized. Basically, background noise can be attributed to irregularities in the oxide particles, local impurities, and standard of coating, and is also a function of instantaneous applied field. From this is deduced the undesirability of magnetized heads, asymmetrical or impure bias waveform, and the slightest speed fluctuation or vibration of the tape. The only specific aging effect known in tape recordings is the echo effect. It depends upon time of contact, time elapsing after recording or erasing before contact takes place, and time elapsing after separation of the tapes. The effects of repeated erasure, not necessarily at a constant level, are mentioned. The difficulties facing standardization of tapes are discussed. Under most of the headings, the necessity for further research on the behavior of the magnetic particles is stressed.

Grammelsdorff, F., and Guckenburg, W., "Classification of Magnetic Tapes. A Contribution Towards Standardization. I–II." *Funk und Ton*, Vol. 6, pp. 247–257; May; pp. 311–325; June (In German). It is generally assumed that standardization must inevitably call for standard reference tapes and heads. This new approach avoids these requirements by classifying a tape primarily according to the value of its constant $\lambda_1$ where $\lambda_1$ is the wavelength at which the external magnetic field, assuming, of course, constant recording intensity, has fallen through demagnetization to $e^{-1}$ of its value at very long wavelengths. On the assumption that demagnetization causes the flux to fall off exponentially with decreasing $\lambda$, $\lambda_1$ is the wavelength for which the theoretical output voltage is a max., all losses besides those of the tape itself being eliminated, and is quite near to the max. point when the losses are included. Series of characteristics are shown indicating the cumulative effects of these losses which include those in the heads and that due to the finite gap. Methods are shown whereby losses can be segregated; *e.g.*, by measuring the characteristic of a recorded tape at several playback speeds. On the basis of a limit $\pm 2$ db for the discriminating power of the ear, a corresponding tolerance, $\Delta\lambda_1$ is derived for $\lambda_1$. Based on these results a standards table of tape parameters is drawn up, thereby enabling the suitability of a tape for a specified equipment to be easily assessed.

Greiner, J., "Experiments on Magnetic Anisotropy in Magnetic-Recording Tapes." *Nachrichtentechnik*, Vol. 2, pp. 197–201; July (In German). Magnetic anisotropy in ferromagnetic materials is mainly dependent upon particle shape and the degree of orderly arrangement of the particles, since demagnetization is in turn dependent upon these factors. Whether spherical or acicular particles are employed, the most pronounced anisotropy appears when the individual particles form chains whose direction coincides with the natural magnetic axes of the particles. To investigate the possibilities of chain formation and its effects, remanence tests were carried out on samples of magnetic tape using a magnetizing coil, from which the sample could be withdrawn, and a search coil and galvanometer. The tests consisted in comparing the remanence curves and hysteresis loops of samples magnetized by the coil (a) in the direction of the coating and (b) normal to it. Corrections were applied, from comparison of saturation values, where the (b) samples had to be prepared by cutting them out from a row of normal $\frac{1}{4}$ inch strips stuck down side by side on an adhesive base. Two types of tapes were tested in this way, one of which showed no anisotropy, the other $\sim$12 per cent, although from chemical, spectro-analytic, and X-ray grating tests, the magnetic material was $\gamma$-$Fe_2O_3$ in both cases. To test whether the anisotropy arose from chain formation caused by magnetic orientation, ten measuring tubes 60 cm long, $7\times7$ cm cross section, were filled with $\gamma$-$F_2O_3$ dispersion and allowed to dry while subjected to constant magnetic fields of various strengths. Remanence curves subsequently plotted showed an increase in remanance of the aligned over the unaligned columns, rising as the aligning field rose from 0 to 500 oersteds.

Herr, R., and Von Behren, R. A., "Selective Erasure of Magnetic Tape Cross-Talk." *Electronics*, Vol. 25, pp. 114–115; August. A description of the practical application of this technique to one type of magnetic tape. Generally a small erase current, $\sim0.1\times$normal, was found to reduce print-through signals, (1) 6–8 db without affecting the recorded signal at all, or 2) 10–12 db with a recorded signal reduction of $\sim$1 db. However, as the erase-head design was found to affect the relative reduction of lf and hf signals, tests were carried out with three types of erase heads; (a) with an airgap of 0.001 inch, (b) with an airgap of 0.02 inch, and (c) one of the form of a solenoid through which the tape is threaded and which gives a more uniform field in the magnetic coating. A 1 kc and an hf signal were recorded on the tape. 16 hours after storing at 65°C, for a given reduction of the printed signal the 1 kc signal was found to have fallen approx. the same in all cases, but the hf signal was slightly less reduced with head (c) than (b) and substantially less than with (a). Based on these results, a practical procedure particularly applicable to professional recording, is outlined. The fact that the technique can be used with certain tapes only is emphasized.

Hittle, C. E., "Twin-Drum Film-Drive Filter System for Magnetic Recorder-Reproducer." *Society of Motion Picture and Television Engineers Journal*, Vol. 58, pp. 323–328; April. Use of two drums in tight-loop type of film-drive filter system solves the problem of film support in magnetic recorder-reproducer utilizing two separate magnetic head assemblies. Performance of filter system is analyzed.

Hust, L. B., "Tape Recorder Takeup Clutch Assembly." *Radio and Television News*, Vol. 47, p. 138; February. Design information and description of a clutch planned to assure smoother operation of many types of tape recorders.

Kolb, O. K., "Some Aspects of Magnetic Sound Recording." *British Institution of Radio Engineers Journal*, Vol. 12, pp. 307–316; May. A brief history and a description of normal equipment are given. Operation without bias, with dc bias and with the far superior hf bias are compared. Explanations of the operation of hf bias according to Wetzel and to Montani are discussed in detail. Zenner's attempt at a mathematical approach by considering the fit of a 5th order equation to the B-H curve is described. In a study of mechanism of erasure, the practical impossibility of removing the last traces of an hf erasing signal and the improved erasure obtained with an ac-mains mass erasure are pointed out. The surprisingly small improvement obtained by erasing at very low speed is mentioned.

Lane, J. D., "Automatic Communications System." *Electronics*, Vol. 25, pp. 168, 170; October. The Robo-communicator is used as a terminal equipment for automatically answering and recording calls. It will also record and reproduce spoken messages, 2-way network conversation, etc. When answering a call, it provides an identification signal and a statement that the incoming message will be recorded. At the completion of the call it disconnects itself from the network. An electro-magnetic transducer, pick-up preamplifier, recording isolation amplifier, and high-note boost amplifier feed one or two wire transports (wire recorders?), calling signals tapped from the avc circuit being fed to the line by a relay control amplifier and power amplifier. Relays couple either external communication lines or local microphones to the recording system. A further relay permits playback from one of the transports, the

two recording units being adequately isolated. No detailed circuit diagram is provided.

Leevers, N., "Magnetic Recording in Film Production." *British Institution of Radio Engineers Journal*, Vol. 12, pp. 421–427; August. There are two fundamental requirements for adaptation of magnetic recorders for sound films; sound record must at all times be held in accurate synchronism with associated picture and yet at same time, it must be physically separate to permit editing; details of equipment for this purpose which makes use of twin channel magnetic tape carrying synchronizing signals.

Lovichi, A., and Deriaud, J. P., "Structure Cristalline et Properiétés Électro-Acoustiques des Films Magnétiques." *Onde Electrique*, Vol. 32, pp. 275–288; July. Two classes of magnetic tape are recognized, "high-speed" (hs) and "low-speed" (ls) the latter being especially characterized by a superior hf response. All the usual electro-acoustic characteristics are studied and in particular the selection of optimum bias level is explained. These characteristics are given and compared in the case of a hs and a ls tape, the ls tape proving superior in all respects except that (a) at optimum bias the percentage distortion is slightly higher and (b) the magnetic properties alone cannot determine the noise qualities. A procedure for evaluating the percentage 3rd harmonic using Taylor's theorem and the normal B-H curve is shown. The dependence of erase efficiently upon the slope of the B-H curve at the point corresponding to max. erase current is also suggested. Electron-microscopic tests show that hs particles are cubic whereas ls particles are acicular and accordingly susceptible to orientation. Tests were carried out on cubes of oxide allowed to set in collodion whilst under the influence of a steady magnetic field. The hs oxide cubes were unaffected; the ls blocks exhibited anisotropy with a higher remanence in the direction in which the magnetic field had been applied. Similar results were experienced when tapes were coated in the presence of a constant magnetic field.

McProud, C. G., "Universal Amplifier for Magnetic Tape Recorder." *Audio Engineering*, Vol. 36, pp. 17–19; May; pp. 24–25, 34–36; June; pp. 22–23, 41–42; July. Features of amplifier for home high quality music systems and in professional applications; *e.g.*, as broadcast remote amplifier. May: Circuit description, and complete schematic of amplifier chassis including parts list. June: Principles underlying amplifier design. July: Constructional aspects, power supply and other particulars.

"Magnetic Sound on 16 mm, Edge-Coated Film, a Short Review of a Current Trend." *British Kinematography*, Vol. 21, pp. 15–19; July. The recording and reproduction of sound by means of magnetically coated film has been developed in recent years that from the point of quality, signal-to-noise ratio and ease and economy in use it is one of the best available methods.

"Mechanism of Magnetic Recording." *Wireless World*, Vol. 58, pp. 47–50; February. Theory describing influence of asymmetrical hysteresis on recording characteristics of magnetic recording; dependence of waveform distortion on gap length; variation of sensitivity and distortion with amplitude of hf bias; experimental data also given.

Menard, J. Z., " A New Recording Medium for Transcribed Message Service." *Bell System Technical Journal*, Vol. 31, pp. 530–540; May. A magnetic recording medium composed of rubber impregnated with magnetic oxide and lubricant is particularly suited to applications requiring the continuous repetition of short transcribed messages. It affords exceptional life, reliability, and economy in telephone applications, where it is utilized in the form of molded bands stretched over cylinders of the recording mechanisms.

Molyneux, L., "Recording Low Frequency Phenomena on Magnetic Tape." *Electronic Engineering*, Vol. 24, pp. 130–131; March. Such phenomena occurring in the field of medicine are difficult to record direct on magnetic tape because of the poor vlf response. This drawback is overcome by the use of a form of fm. The signals to be recorded are taken through a cathode follower to a transitron Miller integrator circuit whose natural frequency is apparently ~3.3 kc. Positive signals raise the frequency; negative signals lower it, giving linear fm from 1.0 to 5.5 kc for a voltage range of ±11 v. An amplifying triode tube passes the transitron output to a high-impedance recording head. A direct-reading frequency-meter circuit with low-pass filter is used for demodulating on the playback side. The over-all frequency-meter circuit with low-pass filter is used for demodulating on the playback side. The over-all frequency response is flat from 0 to 50 cps afterwards falling by 3 db at 100 cps. The voltage gain is $\frac{1}{5}$. Two recordings of a signal on paper, one direct and the other including this intermediate link, show great similarity.

"Noise Recording Simplified; General Electric Co." *Steel*, Vol. 131; pp. 107+; July 14. An application of the familiar tape recorder for purposes of isolating sound with a view to laboratory investigation and subsequent analysis.

Parkin, P. H., and Taylor, J. H., "Speech Reinforcement in St. Paul's Cathedral." *Wireless World*, Vol. 58, pp. 54–57; February; pp. 109–111; March. Brief report also in *Nature*, Vol. 169, pp. 214–215; February 9. The large reverberation time, up to 11 seconds empty and 6 seconds full of St. Paul's plus the lack of absorptive material make speech very difficult. Frequency limitation in several other buildings is discussed and a suitable speech range is arrived at for St. Paul's. For intelligible speech, the intensity of the direct speech must always be greater than that of the reflected. Formulas are given showing the energy of direct and reflected waves. It is shown that under certain conditions the distance covered before direct and reflected powers are equal is 9 times greater with a directional than with a point source. For St. Paul's a "line" source of 11 lf speakers and 9 hf were arranged in a vertical column which produced a fan-shaped horizontal polar diagram but an exceedingly narrow vertical one to prevent reflection from the upper part of the building. To give the effect of all the sound coming from the pulpit the sound is recorded on a disk with variable position playback heads placed to give a delay up to 15 msec for some speaker columns. Erasure of the recording takes place after each revolution. A table of speech intelligibility with and without delay is given.

Rabinow, J., "Notched-Disk Memory." *Electrical Engineering*, Vol. 71, pp. 745–749; August. New magnetic device, developed at National Bureau of Standards, combines advantages of large storage capacity with rapidity of access, magnetic pulses are stored on both sides of thin notched metal disks; disks are aligned with planes of disks parallel to each other and perpendicular to toroid shaped ring in which they are mounted; tests have demonstrated that data can be reached in about 0.5 seconds.

Read, Oliver, *The Recording and Reproduction of Sound*. 2d ed. Indianapolis, H. W. Sams. 790 p; 1952.

"Reel Review; News, Trends, and Review of Magnetic Tape Recording." *Radio and Television News*, Vol. 47, pp. 132, 134, 136; May. Ways and means of using magnetic tape for education and entertainment.

Rettinger, M., "Azimuth Film Calibration." *Audio Engineering*, Vol. 36, pp. 15–16; April. Azimuth film is magnetically-coated film on which signals have been recorded by a head whose gap is truly perpendicular to the direction of travel of the medium. Such a film, or tape, is used to align recording or playback heads, so eliminating the inevitable losses arising from misalignment. A special head is constructed with two symmetrical gaps on opposite sides of it, these gaps being lapped to ensure that the pole faces are in the same plane. An hf recording is made using the front gap. The film or tape is then turned over and playback carried out on the back gap. This process is repeated with different angles of tilt of the head, one way and the other, until the angle is found at which max. output is achieved. This clearly indicates perfect alignment. Slightly tapered drums with flanges are used as guides to ensure a constant travel path of the film, which must itself be straight and noncurly. A head is adjusted with this master tape by setting its alignment until max. output is obtained on replay. Alternatively, the master tape must carry signals recorded at different alignment angles, in which case the test head is set to give max. output on the zero-angle recording.

Satterthwaite, W. F., "Methods for Developing New Applications of Ferrites." *Ceramic Age*, Vol. 59, pp. 51–52; June. Ferromagnetic spinel has appearance and mechanical properties of ceramic and is manufactured by process used in making ceramics; from electromagnetic properties, degree of squareness of hysteresis loop and *Q* characteristic of material at selected frequencies can be determined; activities in magnetic tape recording; pulse transformers; electronic computers.

Schiesser, H., and Schmidbauer, O., "Beitrag zur Normung der Magnettontechnik." *Frequenz*, Vol. 6, pp. 222–229; August. For performance standardization on the use of standard tones at the beginning of a tape reel, while theoretically sound, is too lengthy in practice. The use of reference tapes leads inevitably to the necessity for reference heads, specified bias current, etc., as well, a technique undesirably rigid while involving components which are very liable to change and wear with time. The specification of a recording-current characteristic in terms of a time constant (RC) with different values for different tape speeds was an improvement but the transference of this concept to the playback output characteristic of an ideal head was found superior.

Corrections for gap, iron and contact losses must be applied and their evaluation is discussed at length. Accordingly, recommended correction figures are given for the standard tape speeds together with corresponding time constants for the recording current characteristic. The effects, however, of interaction between tape and pickup head have also to be taken into account and this necessitates a knowledge of the absolute value of the remanent magnetization which in turn calls for a determination of the magnetic "efficiency" of the tape. This is effected by measurements with wide gaps at lf, by magnetometer measurements using a bundle of short magnetized tape strips as the test piece, or by probe heads. Efficiency figures of ~55 per cent result. The interdependence of remanence, coercivity, initial permeability and coating thickness on the one hand, and the working characteristics of sensitivity, frequency response and critical bias current on the other, is discussed.

Schiesser, H., "Einfluss der Betriebsbedingungen auf die Qualitätskenngrösses bei der magnetischen Schallaufzeichnung." *RTI-Mitteilungen*, no. 11, p. 40.

Schmidbauer, O., "Das Feld des harmonisch magnetisierten Tonbandes. Die Abtastung im Leerlauf bei idealem Hörkopf und bei extremer Spaltbreite." *Frequenz*, Vol. 6, pp. 281–290; October. The magnetic field is studied with particular consideration to the influence of coating thickness and permeability. Tests on a reel of tape inserted inside a magnetizing coil establish the fact that the magnetization in a tape is essentially longitudinal. On this basis and with the restriction that wavelength < tape width, a lengthy analysis is undertaken from which (a) the field of a magnetized tape, either isolated or close to an ideal playback head, can be plotted; and (b) the frequency characteristic of the flux through either an ideal head or a wire head or of the leakage flux at the back of the tape can be evaluated. Tests with heads approaching ideal qualities and with a special wire head which ensures constancy of separation of tape and wire confirm calculated values. The justification for the restriction on wavelength, mentioned above, is also proved.

——— ——— *Ibid.*, pp. 319–324; November. Careful tests have shown that the null points which appear in the frequency response and which are attributed to the gap effect are not strictly harmonically related. This alone, apart from magnetization due to hf bias and inevitable slight speed variation, could account for the actual appearance in practice of minima and not null points. A careful analysis of the playback emf is carried out in the case of a very thin tape and a wide gap whereby the effects of coating thickness and permeability can be ignored. This emf arises from three separate flux components in the tape: 1) where it spans the gap, 2) where it rests against the head, and 3) where it leaves the edges of the head. The emf arising from 3) produces a marked waviness in frequency response at lf in the case of heads with narrow gaps and sharp edges—as opposed to the normal ring-type head—but can otherwise be ignored. Terms 2) and 3) produce a frequency response curve with clearly defined null points not harmonically related and maxima rising 2 db per order; *i.e.*, per octave. A good approximation for the position of the null points is given by the expression, $f_0 n = nf_0 - 0.2f_0/n$ where $f_0 n$ is the null frequency of order $n$, and $f_0$ = tape speed/gap length.

Schwarz, K., "Beitrag zur Kläung des inneren Mechanismus der Magnetton-Aufzeichnung." *Ibid.*, p. 37–44; February. The mechanism of magnetization and demagnetization of permanent bar magnets is extended to explain the mechanism of magnetic tape recording. Of the three possible forms of magnetization two only are of importance, along the tape, lengthwise, and through it, perpendicular. The frequency characteristic with lengthwise magnetization rises linearly with frequency, as is well known. With perpendicular magnetization, however, the curve, although of the same general shape, starts at zero frequency with a finite value. A close examination of the mechanism of playback, backed by experimental results, reveals the importance of the perpendicular component, a contribution not generally realized. It also explains the relative unimportance of the air gap length on recording, though this does not hold with reproduction. Static magnetization characteristics for strong, weak, and no hf bias are shown and the advantages of working under the first named conditions explained. Sources of nonlinear distortion are described. These include distortion of waveform of flux distribution in the tape and the transfer effects.

Singer, K., and Ward, H. C., "A Technical Solution of Magnetic Recording Cost Reduction." *Society of Motion Picture and Television Engineers Journal*, Vol. 58; pp. 329–340; April. This new portable magnetic recording channel, designed primarily for 17½ mm film provides high-quality operation and all of the needed facilities for production recording. By operating at 45 feet/minute a considerable economy in film cost is realized and the size and weight of the recorder are reduced. The recorder is also adaptable for 16-mm or 35-mm film. A new amplifier system utilizing miniature tubes and small components is provided as part of the equipment.

"Speech Amplification System in St. Paul's Cathedral." *Engineering*, Vol. 173, pp. 12–13; January 4. The equipment described reduces the reverberation effect due to the dome without the need for excessive bass cutoff and produces by means of controlled delay, the illusion that all the sound is coming direct from the pulpit. The mean projection unit is a vertical column of loudspeakers near the pulpit, consisting of eleven 10-inch units spaced along the center line of the baffle with nine 3-inch units in a row to one side. The crossover point is ~1.4 kc. Ten smaller assemblies are mounted on pillars in the nave, somewhat high up and accordingly included downwards. The lengths of the sources restrict upward and downward spread and so reduce echo from the roof. The delay unit consists of a motor-driven turntable with a loop of magnetic tape around the periphery. Converted sound from the microphone is recorded on the tape at one point and picked up on playback heads located round the periphery at points which will give the correct delay corresponding to any specific loud-speaker location. An erase head is interposed between the last playback head and the record head. Two floor frames accommodate the delay unit, amplifiers, etc. The installation has yet to have volume levels and location of loudspeakers finally settled.

Sucksmith, W., "Stainless Steel Magnetic Recording Wire." *British Electrical and Allied Industries Research Association Technical Report* N/T 61. 6p. See also *Metal Treatment and Drop Forging*, Vol. 19, pp. 545–546, 549; December. Investigation into magnetic properties of wire in light of theories of Stoner and Wohlfarth on one hand and Neel on other, on shape anisotropy mechanism of hysteresis in heterogeneous magnetic alloys.

"Supervisors Just Dial 80 and Get All the Facts; American Maize Tape Recorder-Phone Network." *Food Engineering*, Vol. 24, pp. 147–149; October. Vital management decisions and company information quickly spread to them via unique American Maize tape recorder-phone network.

Tafel, H. J., *Untersuchung des Kopiereffekts beim Magnetofonband.* Dissertation Techn. Hochschule, Stuttgart; 1952.

Tall, J., "Using Hearing Characteristics in Tape Editing." *Audio Engineering*, Vol. 36, pp. 15–16, 50–51; May. Magnetic tape or film techniques useful in production of radio and television broadcasts, commercial records, and motion pictures; factors in obtaining "naturalness"; effect of human hearing, ear sensitivity, hearing fatigue, and persistence of sensation of hearing; problems involved in matching of background sound; splicing and editing pointers for professional results.

"Tape Duplicating Equipment." *Electronics*, Vol. 25, pp. 220, 224, 228; September. Brief mention of duplicating techniques for magnetic tapes.

"Transformer Noise Study Simplified with Tape Recorder." *Electrical Engineering*, Vol. 71, p. 783; September. General Electric engineers use a magnetic tape recorder to gather sound data on transformer noise. Later, in the laboratory, the tape recording will be played back for sound level determinations and frequency analyses.

Tunnel, B. A., "Agency Uses Tape Recordings to Help Copy Writers; Recorded Interviews with Customers." *Advertising Agency*, Vol. 45, pp. 90+; April.

Werner, P. H., "The Mechanical Properties of Various Magnetic-Recording Tapes and their Influence on Recording Quality." *Technische Mitteilungen PTT*, Vol. 30, pp. 173–180; May (In German and French). In operation all tapes exhibit longitudinal vibrations which give rise to undesirable modulation of the recorded signals. The frequency of the vibration is determined from the elasticity, specific gravity, length, and tensile stress. Loading vs elongation curves for several proprietary tapes show very similar moduli of elasticity but widely varying yield and breaking points. The resonant frequencies of 1 m lengths of all these tapes were calculated. Experimental checks also were carried out by stretching the tape length between the cutter of a gramophone recording head and the needle of a pickup, the pickup output exhibiting a

peak as the input frequency to the recorder passed through the tape resonance. The resonant frequencies of all the tapes lay within the range 675–860 cps. Fixed guides and heads give rise to aperiodic vibrations in the tape due to friction and a method of measuring this effect, similar to a dynamic brake test, is described. The needle of a pickup presses against the tape and indicates the vibration amplitude. Rotating guides, having no motion relative to the tape, act as barriers and prevent propagation of the vibrations beyond them. Accordingly, all guides should rotate if possible. Furthermore, an additional rotating guide can be introduced with advantage between recording and playback head.

White, D. J., and Stutz, W. H., "Compacting Field-Type Magnetic Film Sound-Recorder." *Electrical Manufacturing*, Vol. 49, pp. 100–103, 256, 258, 260; January. Miniaturization techniques result in high fidelity portable system for motion picture use with total weight of both drive unit and recording amplifier unit only 38 lb; basis of design is drive system using dual inertia wheels that permits reduction of size and weight of all components while maintaining high degree of essential motion stability; elements include receding arms supporting film handling mechanism and silicone oil spring damping device.

Whitney, Philip, "Automatic Station Break Announcer." *Tele-Tech*, Vol. 11, pp. 47, 80; July. Cessation of average program level actuates relay circuit which plays tape recorded announcement. Cam and motor timing device prevent false operation.

Williams, F. C. and others, "Universal High-Speed Digital Computers: Magnetic Store." *Institution of Electrical Engineers Proceedings* Vol. 99, Part 2 (Power Engineering), pp. 94–106; Discussion, pp. 120–123; April. See also abstract in *Engineer*, Vol. 192, pp. 737–738; December 7, 1951. Rotating wheel gives high transfer speeds and short access time to date which are transferred directly to high speed cathode ray tube store of computer; new method of digital representation employed for data storage; system incorporated at Manchester University computer; illustrations.

Wortman, L. A., "Magnetic Tape and the CBC." *Radio and Television News*, Vol. 47, pp. 38, 84; June. The maximum utilization of tape recordings permits the Canadian Broadcasting Corporation to service its many networks from coast-to-coast as well as overseas.

——— "Magnetic Tape Duplication." *Ibid.*, Vol. 47, pp. 40–41, 134; April. Here is one approach to the duplication of high quality prerecorded music. Information on other companies' methods will be given in later issues.

——— "Unique Magnetic Tape Applications." *Ibid*, Vol. 48, pp. 38, 112; July. A diversified group of organizations have adopted magnetic tape to solve special problems.

## Miscellaneous

Harvard University. Computation Laboratory, *Investigations for Design of Digital Calculating Machinery*. Separate parts described below from Library of Congress, Publication Board Project, Washington 25, D. C., giving PB number of each part.

Progress report no. 1, covering period May 10, 1948–August 10, 1948. August, 1948. 17p. PB 112924. Contents: *I. Dynamic Magnetic Recording*, by Eugene Grant, John Rothery, Peter Lindley. *II. Static Magnetic Recording*, by Howard Aiken, An Wang, Wag Dong Woo. *III. Logical Design of Vacuum Tube Control Circuits*, by William Burkhart and Theodore Kalin.

Progress report no. 2, covering period August 10, 1948–November 10, 1948. November, 1948. 109p. PB 112923. Contents: *I. Instruction in Applied Mathematics with Special Reference to Automatic Calculating Machinery. II. Dynamic Magnetic Recording*, by Eugene Grant and Peter Lindley. *III. Dynamic Magnetic Recording Process, Theory*, by John Rothery. *IV. Static Magnetic Storage*, by An Wang. *V. Logical Design of Vacuum Tube Circuits for Computing Machinery*, by Howard Aiken, William Burkhart, Theodore Kalin.

Progress report no. 3, covering period November 10, 1948–February 10, 1949, by Peter Lindley and Martha Whitehouse. February, 1949. 251p. PB 112925. Contents: *I. Instruction in Applied Mathematics with Special Reference to Automatic Calculating Machinery. II. Dynamic Magnetic Recording*, by Peter Lindley. *III. Accurately Timed Master Pulses*, by Eugene Grant. *IV. Magnetic Recording Theory*, by John Rothery. *V. Static Magnetic Storage and Delay Line*, by An Wang. *VI. Solid Tubes for Computers: Ferromagnetic and Semi-Conducting Controls to Replace Vacuum Tubes in Automatic Calculating Machines*, by Miles Hayes. *VII. Design for Bulk Storage*, by Eugene Grant, Elbert Little, Dexter Smith, Robert Wilkens. *VIII. Logical Design of Vacuum Tube Circuits for Computing Machinery* (continued from Progress report no. 2, part V, sec. 3) by Howard Aiken, William Burkhart, Theodore Kalin. *IX. Table: Minimal Vacuum Tube Operators for the Switching Functions of Four Variables.*

Progress report no. 4, covering period February 10, 1949–May 10, 1949, by Peter Lindley and Martha Whitehouse. May, 1949. 168p. PB 112973. Contents: *I. Computation Service. II. Logical Design of Vacuum Tube Circuits for Computing Machines* (continued), by Howard Aiken, Theodore Kalin, and William Burkhart. *III. Dynamic Magnetic Recordings*, by Peter Lindley and Wag Dong Woo. *IV. Magnetic Trigger Circuit*, by John Rothery. *V. Static Magnetic Storage and Delay Line*, by Miles Hayes. *VI. Static Magnetic Delay Line Construction and Application*, by Robert Wilkins and Peter Lindley. *VII. Crystal Class A Gates*, by An Wang. *VIII. High Speed Storage: Mechanical Design*, by Dexter Smith. *IX. Designs for High Speed Printers*, by Elbert Little.

Progress report no. 8, covering period February 10, 1950–May 10, 1950, by Richard Hofheimer and Holly Wilkins, May, 1950. 158p. PB 112964. Contents: *I. Logical Design of Vacuum Tube Circuits for Computing Machinery* (continued), *Part II: Multipliers. II. Large Scale Digital Calculator Projects*, by Elbert Little. *III. Electronic Synchronization of Motors*, by Leonard Butsch. *IV. Class A Gates Using Germanium Diodes*, by Richard Hofheimer. *V. Magnetic Clutches for Tape Drives*, by Robert Wilkins. *VI. Vacuum-Operated Tape Drive*, by Robert Wilkins. *VII. Testing Magnetic Clutches*, by Milton McDowell. *VIII. Static Magnetic Delay Lines*, by An Wang. *IX. Tape-Record Circuit using the New Raytheon Thin Pole Piece*, by Guy Boucher. *X. Printing Systems*, by Marshall Kincaid. *XI. Application of the Magnetic Power Pulse Gate*, by Howard Cohen. *XII. Electrochemical Computer Elements*, by Gerrit Blaauw.

Heidenwolf, Hermann, *Verfahren zur Mikroskopischen Sichtbarmachung Magnetischer Tonaufzeichnungen*. PB 97013. 8p. (Text in German and English).

Lloyd, G. G., *Miscellaneous German Radio and Communication Targets. BIOS Final Report* 153. 5p. Notes that reports have appeared on the field model of the Magnetophon recorder, made by AEG and known as "Ton Sb" and "Ton Sc." The studio model of this recorder was seen and heard.

Reichsstelle fur Hochfrequenzforschung, Berlin. Reports on high frequency, superconductivity, magnetic sound recording. *FIAT Microfilm Reel F8, Frames 1–329.*

Shaney, A. C., *Advantages of Magnetic Tape over Magnetic Wire Recording*. New York, Amplifier Corp. of America (398 Broadway). Nine advantages of tape over wire.

Stewart, W. E., and Anderson, L. J., *High-Fidelity Magnetic Recording Tape Heads*. Camden, N.J., Radio Corp. of America, RCA Victor Division. Unpublished, according to author.

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Carmen F. Wilson received her collegiate degree from Northwestern University and continued her professional education at the Library School of the University of Illinois.

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She began her career at Northwestern University where she supervised the opening years of the University's Technological Institute Library. In April, 1947, she joined the staff of the John Crerar Library in Chicago as a reference assistant. She was appointed to the position of Chief of the Technology Department on September 1, 1950, and is presently employed in this capacity.

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