Meetings

Acoustical Society

San Diego Meeting Attracts 350

The most recent West Coast meeting of the Acoustical Society of America took place late last year in San Diego's Balboa Park, where the especially well-attended sessions on aircraft noise were punctuated from time to time by illustrative sound effects from both jet and propeller-driven aircraft flying overhead. The three-day meeting, which began on Thursday, November 13th, was attended by some three hundred and fifty registrants, more than two hundred of whom also attended the Society's informal dinner at the U. S. Grant Hotel on Friday night to hear Lee A. DuBridge, president of the California Institute of Technology, speak on "Physicists in California".

Of the ninety papers making up the technical program, eleven were invited addresses. Two of these, by Hugo Benioff of the Caltech Seismology Laboratory and by Louis B. Slichter of the Institute of Geophysics at the University of California at Los Angeles, introduced the meeting's first session, which dealt with acoustical phenomena and techniques in seismology.

The aircraft noise program, under the chairmanship of Richard H. Bolt of the Massachusetts Institute of Technology, provided convincing evidence that the aircraft industry, the government, and a large number of acoustical laboratories are devoting much time, effort, and money in an attempt to gain a better understanding of the noise problem and to provide better means of aircraft noise control.

The steady pressure of military demands for rapid development of high-powered aircraft, on the one hand, and that of a growing public reaction against unwanted noise, on the other, have focused attention on noise control as an immediately important region of aeronautical research. One of the chief difficulties, it was emphasized, is that noise control measures have not always been able to keep up with the pace set by aircraft development, which has not only posed a serious economic problem in terms of replacing costly control facilities, but has also had the effect of inhibiting certain types of aircraft power-plant research and development. Theoretical results have been encouraging for some aspects of the propeller noise problem, it was suggested, but jet engine designs for aircraft present a far more threatening aspect in terms of their contributions to a noisy America, and at the same time offer a direct challenge to acoustical scientists.

Other sessions of the meeting covered such topics as electroacoustic transducers, the calibration of transducers, hearing, loss of auditory function after exposure to sound, and the attenuation, scattering, diffraction, and propagation of sound.

Particle Accelerators

Brookhaven Conference Reported

The high-energy accelerator conference held on December 16 and 17, 1952, in conjunction with the dedication ceremonies of the cosmotron at Brookhaven National Laboratory, Upton, N. Y., was attended by over one hundred scientists, including many visitors from European, Canadian, and Mexican laboratories, as well as representatives from the major accelerator centers of the United States.

The sessions of the first day were devoted, in the main, to descriptions of existing machines and proposed modifications. The talks were grouped according to machine species: frequency-modulated cyclotrons and linear accelerators were discussed in the morning, and synchrotrons, both proton and electron, in the afternoon. Discussions on the second day were concerned chiefly with the new alternating-field-gradient type of machine, both of the circular synchrotron and linear accelerator variety. The present state of the theory was presented together with some discussion of the difficulties recently realized in connection with inhomogeneities in the magnetic field. This was followed by several design proposals both of a general nature and for specific energy values. At the end of the meeting, members visited the cosmotron for a demonstration of this machine in operation at 2 Bev.

The subject of frequency-modulated cyclotrons was introduced by R. L. Thornton, of Berkeley, who remarked on the simplicity and reliability of these machines. For example, the 184-inch cyclotron at Berkeley is now in operation at 95% monthly efficiency on a 20-hour day, 7-day week basis. However, the great need at the present is to obtain better external beams free of the background radiation that is so troublesome when using internal targets. Only 0.1% of the circulating beam is now extracted at Berkeley and that only for a few tenths of a microsecond. Other means are under investigation, in the hope of improvement. Changes now being planned in this cyclotron include a reduction of magnet gap and additional magnetizing coils so as to obtain 730 Mev protons, 450 Mev deuterons, 900 Mev alpha particles, or 1.1 Bev He^3 nuclei. Experiments on a vibrating reed to replace the rotating capacitor are in progress.

At the University of Chicago, the 170-inch cyclotron is used mainly to produce 450 Mev protons. The protons bombard a Be target to produce mesons that are sorted by the stray magnetic field of the machine into beams ranging in energy from 66 to 227 Mev. Experiments mentioned by H. L. Anderson included meson scattering by liquid hydrogen, neutral pi meson production by proton-proton collision, neutral pi meson production by neutrons, and a search for neutral V particles.

C. J. Bakker of the Netherlands described the present plans for the 600 Mev synchro-cyclotron that will be one of the main facilities in the new European laboratory to be established in Switzerland. In June, 1952, the European Council for Nuclear Research (CERN) decided to build such a machine, and it is hoped that by June, 1953, the design studies will be complete and that orders can be placed at that time. Personnel from seven European countries are working on this project. The design specifies a magnet of 5 meters diameter, weighing about 2500 tons. To obtain the required radio-frequency range of 34 to 17 megacycles, experiments are proceeding on an aluminum "tuning fork" like that being tested at Berkeley.

Unusual features of the Carnegie Tech synchrocyclotron include a selenium rectifier as power supply for the low voltage, high current coil. E. C. Creutz outlined the careful orbit studies that have been made with this machine.

Both the Rochester cyclotron and the Columbia cyclotron are in need of extra shielding, at present.

Opening the discussions on linear accelerators, L. W. Alvarez pointed out that the most important advantage of proton linear accelerators over cyclotrons is the much higher intensity attainable in the external beam and the longer time over which the beam can be made available. In the Berkeley proton linac, about ½ microamp of protons at 32 Mev is now available over 500 microseconds at a 15-cycle repetition rate. Alvarez felt that, with the new linac focusing technique due to J. P. Blewett, energies in the 600-Mev range may now be quite practicable.

The Stanford electron linear accelerator, which is designed to accelerate electrons to 1 Bev, now has the full 220 ft length of its accelerator tube in place, according to E. L. Ginzton. Of the 22 driving klystrons, only 10 are now operating at half power to produce 350 Mev electrons. The measured current at the 80 ft point is 10^{12} electrons per pulse which, at a pulse rate of 60 per second, gives an average current of 10 microamps. Speculating on future developments, Ginzton thought that, with a rebuilt power supply, operation at four times the present power level would be entirely possible so that this accelerator might be able to provide 2 Bev electrons.

The relative advantages of dielectric versus metallic loading for the wave guide in an electron linear accelerator were discussed by D. W. Fry of the Atomic Energy Research Establishment at Harwell, England. Theoretically, with dielectric loading, tube diameters and power consumption could be cut to about one third. An experimental 3000 megacycle guide, 80 centimeters long and 2½ inches in diameter, was loaded with dielectric discs of dielectric constant 90 at Harwell. After some early difficulty with electron emission from oil films or other contamination on the discs, operation was in reasonable agreement with theory. At present, a design study for a 600 Mev proton linac is in progress.

Brief reports were made on other linear accelerators already built or under construction. For instance, the MIT linac has now been in operation for two years at 16 to 18 Mev, delivering 3 microamps average current, and is now in use in experiments studying the angular distributions of photodisintegration and photofission. The Yale electron linac is being removed to a new building and is therefore not in operation. At Purdue, one accelerator section producing 4 Mev electrons is now complete. A second similar section will be phased in such a way that the total energy of the machine can be varied from 4 to 8 Mev. Under construction are an electron linac for variable energy from 10 to 50 Mev for the University of Chicago Argonne Hospital by High Voltage Engineering Corp., and a proton linac at the University of Minnesota.

The session on synchrotrons, proton and electron, was opened by G. K. Green with a very comprehensive discussion of the construction and operation of the Brookhaven cosmotron. After remarking that a synchrotron is no better than its magnet, he outlined the extensive design, model measurements, testing, and careful erection of the cosmotron magnet. This effort proved to be very worthwhile. Protons were first injected into the cosmotron on March 11, 1952, and an accelerated beam to 1 Bev was obtained by May 20, 1952. The brevity of this period of beam hunting was due in major part to the excellence of the magnet. Present operation at 2 Bev will eventually be increased to nearly 3 Bev when the pole-face winding generators are installed and energized. Currents in these windings will serve to compensate for effects of saturation in the iron, and so permit acceleration to higher magnetic field values.

Recently, a considerable amount of time has been spent in determining the factors necessary for reliable and consistent operation of the cosmotron. For instance, a detailed study was made of the processes of injection. By using a pulse of protons shorter in time than that required for one revolution, orbits of several revolutions were obtained for many sets of values of all the important injection parameters. Close coupling between radial and vertical oscillations was observed, and it is probable that this mechanism allows the protons to clear the injecting equipment after their first revolution. At present, attention is concentrated on a study of the capture and acceleration processes. With an injected pulse of 5×10^{11} protons, about 4×10^{9} protons per pulse are accelerated in 1 second to somewhat over 2 Bev. The pulses are repeated every 5 seconds.

The present state of progress of the Berkeley bevatron was outlined by W. M. Brobeck. This machine is designed for acceleration of protons to about 6 Bev and it is hoped that trial operation may begin sometime in the autumn of 1953. The pole-pieces have not yet been added to the H-shaped magnet although the rest of the magnet structure and its associated power supply are in place and have been tested. The vacuum chamber is now in the process of assembly. The 10 Mev linac that will serve as injector for the bevatron is not quite complete but it may be finished by February.

News of the 1 Bev proton synchrotron being built at Birmingham, England, was brought to the meeting by L. Riddiford. It is expected that this accelerator may be ready for trial operation sometime in the middle of 1953. The magnet has now been reassembled and has been pulsed to top field without mishap. Windings have been added to correct for a 5% second harmonic in the remanent field. The vacuum chamber is now completely installed and quite high vacua have been obtained (less than 10^{-6} mm without traps). Protons have not yet been injected although the 500 kv voltage-multiplier injector set is installed.

In discussing the Michigan 300 Mev "racetrack" electron synchrotron, H. R. Crane described the way in which betatron preacceleration has been replaced by an initial modulation of the accelerating frequency. This can be done since the electrons are injected at 500 kv, already fairly close to the velocity of light. The r-f system has now been divided into two parts—a dielectric loaded cavity accelerator which carries the electrons through the first 100 microseconds during which the frequency is varied (particle energy is raised to 4 Mev), and a fixed frequency (30Mc) drift tube accelerator which provides the acceleration during the remainder of the cycle. This synchrotron is in use every day, at present on a study of elastic scattering of electrons.

At Cornell, a design study is in progress for a 1 Bev electron synchrotron. The magnet cross section would be about 15 inches square, according to R. R. Wilson, with a peak field of 9 kilogauss and an aperture of 1 in. x 4 in. The orbit radius would be 12.5 feet. Operation as a conventional synchrotron would be possible, although thought is being given to trying an alternating-gradient magnet. Radiation losses of 30 kev per revolution would have to be supplied by the r-f system.

R. V. Langmuir described the electron synchrotron now in operation at Caltech at 500 Mev. This machine uses the magnet and the vacuum chamber from the quarter-scale Berkeley bevatron model. New coils, a new r-f system, and a new injector have been added. For injection, a 1 Mev pulse transformer in oil produces a 200 to 500 milliamp beam of electrons for one microsecond or so. Acceleration lasts for 0.23 sec and the pulses are repeated every second. The r-f system consists of a cavity, operating at 20 Mc which is twice the revolution frequency. Although only 600 volts is needed for accelerating the electrons, the necessity for an additional 1800 volts to compensate for radiation losses at the end of the cycle requires normal operation at 3 to 4 kv across the cavity. Future plans include the addition of pole-tips to the magnet for a peak field of 10,000 gauss to permit acceleration to 1 Bev.

The second day of the conference was devoted primarily to discussions of focusing by alternating-gradient magnetic and electric fields as applied to synchrotrons and linear accelerators. The present status of the theory was outlined by E. D. Courant of Brookhaven who began with a review of the paper by Courant, Livingston, and Snyder [*Phys. Rev.* **88**, 1190 (1952)].

The discovery of alternating-gradient focusing was precipitated by a proposal by Livingston that, in higher energy machines of the cosmotron type, the C-shaped magnets should be placed around the particle orbit facing alternately inside and outside. By this means, effects of back leg saturation and fringing on the shape of the field in the magnet gap could be made to average out with a resultant larger usable magnetic aperture. An analysis of the effects on a proton beam of periodic variations in the n-value revealed the strong focusing. Straight sections can be included in synchrotrons using the alternating-gradient principle but the focusing deteriorates if they are made longer than the magnetic sections.

Phase stability in alternating-gradient machines is not the same as in ordinary synchrotrons. Initially the synchrotron mechanism is inhibited by the strong focusing and the stable phase is on the rising side of the r-f wave, as in linear accelerators. At an energy of several billion volts, the phase stable point shifts to the falling side of the r-f wave. This transition is accompanied by severe damping of the phase oscillations as well as a zero in their frequency.

In England it has been pointed out recently that if, at any time, there is an integral number of betatron oscillations around the circumference of an accelerator, the resonance between oscillation and revolution frequencies will make the particles extremely sensitive to small errors in alignment. To avoid this, the n-value may have to be kept constant to high accuracy. D. W. Fry mentioned that Hine and Adams of Harwell are now using a differential analyzer to study this problem more thoroughly.

Theoretical work at Brookhaven has been corroborated by K. Johnsen of Norway who is working on the CERN project for a proton synchrotron in the 30 Bev region. Design parameters for this machine were outlined both by Johnsen and, later in the day, by O. Dahl who is chairman of this project. This synchrotron, to be built in Switzerland, will be of the alternating-gradient type, will have a radius of curvature of 100 meters and a total diameter of close to 300 meters. A top magnetic field of 10,000 gauss is expected, with an n-value near 4000 in magnetic sections 1.8 meters long separated by straight sections half of 0.5 meter length and half of 1.0 meter length. Iron is already on order for a full-scale two section model of this magnet to be used for dc studies. Plans for housing this European accelerator have been drawn in rough outline with most of the machine in a trench underground. The r-f system might be in the center of the ring with all other equipment including injection and ejection apparatus in a single building enclosing a small section of the orbit.

The general problems of high energy accelerator design were discussed by M. S. Livingston, of MIT, from a cost economy standpoint. Three critical design parameters are: (1) aperture, which determines magnet power, ampere turns, etc.; (2) rise time of magnetic field which determines power supply costs and the cost of r-f systems; (3) length of straight sections. To illustrate the influence of these factors, comparative design

Kodak reports to laboratories on:

our new spectrophotometric solvents . . . an f/0.75 lens . . . reducing records by microfilming . . . *our new guide to successful photomicrography*

Spectrophotometric solvents

The solvents employed in infrared and ultraviolet spectrophotometry are mostly such common ones as

chloroform, cyclohexane, carbon tetrachloride, methanol, iso-propyl alcohol, etc., but highly uncommon is the freedom required from optically absorbing impurities. The primary producers from whom these solvents flow by the tank car are rarely prepared to supply them in spectrophotometric grade and in contamination-resistant 500 cc packaging. We are. (In special 3-liter bottles, too.) In the new 38th edition of the famous Eastman Organic Chemicals catalog we designate them by the prefix "S" before the catalog number. There are an even dozen of them (so far), and we shall be happy to send you a small wall chart that gives their infrared "windows" and ultraviolet cut-offs.

For a free copy of the catalog and/or the chart, or to place your order for solvents, write Distillation Products Industries, Eastman Organic Chemicals Department, Rochester 3, N. Y.

f/0.75

For cases where light must be husbanded to the utmost, as in certain experiments in cine-fluorography, we have developed a lens that forms an image at an effective relative aperture of *f*/0.80 or an equivalent *f*-number of 0.75. Hereby is announced the availability of this lens for any job requiring an optical system capable of laying down an exceedingly sharp, flat image with just about the highest utilization of light rays that today's lens designers can achieve. Here are some vital statistics about this new Kodak Fluro-Ektar Lens, 110 mm *f*/0.75. It's achromatized in the middle of the green (not for ultraviolet use). Designed for 16:1 minification. Gives excellent definition of a 12″-diameter object circle on a ¾″-diameter image, good definition over a 1″-diameter image, acceptable definition out to a 1¼″-diameter image (which corresponds to the corner of the ¾″

by 1″ standard silent 35mm movie frame). Length of element array, 208 mm; distance from object plane to first surface, 1808 mm; distance from rear surface to image plane, 7.3 mm. Price on request.

If you have need for such prodigious lens "speed," we suggest you get in touch with Industrial Optical Sales Division, Eastman Kodak Company, Rochester 4, N. Y.

Microfilming

There comes a day in the growth of a laboratory when the sheer physical volume of accumulated records becomes a menace. One way to keep from being inexorably drowned in paper is to take recourse in a giant-sized wastebasket. But, as night follows day, what is thrown out now winds up next week as a vitally needed scrap of paper reposing somewhere in a bale of waste. The answer, of course, lies in a well-planned system of microfilming which lops off some 98% of the bulk of a mass of records. If you'd like to start thinking about it now, you can find all the facts in a new 60-page booklet we have prepared.

Just ask your Kodak dealer for the Kodak Industrial Data Book, "Microfilming with Kodagraph Micro-File Equipment and Materials." It costs 50 cents.

High speed

As a tool for the engineering analysis of mechanical motions too fast for the eye or even for the sports newsreel type of "slow motion," we make the Kodak High Speed Camera. It can take from 1000 to 3200 full 16mm frames per second and can superimpose the corresponding oscillograph record on the pictures if required. It is simple to operate, and gives pictures of excellent photographic quality. We have sold a very respectable number of them to people who have found its speed range just right for the great majority of mechanical design problems. Nevertheless, there *are* problems, mostly in fundamental research, where simplicity, economy of operation, and even image clarity must be sacrificed for higher repetition rates. Several high speed cameras of such specialized design have appeared in recent years, and we are frank in our admiration of them. The history of this branch of instrumentation dates back at least to 1880 and has its own terminology, literature, regular symposia, and a collection of impressive successes. A scholarly and exhaustive summary of these lately appeared in one of the engineering journals. We have had it reprinted and shall be happy to send you a free copy.

For the reprint ("Special Report on High Speed Photography in Design"), for inquiries about the Kodak High Speed Camera, or for help in selecting film or plates for any form of high speed photography, address Industrial Photographic Sales Division, Eastman Kodak Company, Rochester 4, N. Y.

This is one of a series of reports on the many products and services with which the Eastman Kodak Company and its divisions are . . . *serving laboratories everywhere*

Kodak
TRADE-MARK

parameters were presented for 10 Bev and 100 Bev alternating-gradient synchrotrons.

M. G. White remarked that a small group in Princeton is now considering the design of a circular machine for about 10 Bev, perhaps for electrons. There might be some merit, he thought, in separating the focusing field from the bending field, particularly in view of the apparent necessity for keeping n-value constant.

Design studies being carried on at Brookhaven were summarized by J. P. Blewett. A magnet model has been designed to permit dc measurements of field patterns and to study the effects of saturation. A linear accelerator model is now partially designed that will test alternating-gradient techniques of radial focusing. A cooperative study is being made by Brookhaven and the Philips' Laboratories of Holland on the properties of ferrites in the range from 3 to 20 Mc for possible use in accelerating at a high harmonic of the particle revolution frequency.

Turning to linear accelerators, Blewett pointed out that the alternating-gradient focusing principle applies as well to electric fields as to magnetic ones and such a focusing technique can be particularly useful in overcoming the inherent radial instability present in the linear accelerator. The results of a theoretical study [*Phys. Rev.* **88**, 1197 (1952)] were reviewed and attention was drawn to other possible electric field distributions than those in existing linacs.

The conversion of the Berkeley proton linac to alternating-gradient focusing by Nunan and Watt was reported by L. W. Alvarez. The focusing fields have been held down to 7 kv across a 2 cm gap so as to avoid breakdown difficulty, but with the new lenses the current density has been increased by a factor of about 20.

Further comments included the calculation by R. Sternheimer of Brookhaven for an alternating-gradient magnet system for focusing mesons from the cosmotron. L. Riddiford remarked on the possibility of using an air-cored magnet for an alternating-gradient synchrotron. Although the stored energy is so large, its small size and simplicity of construction should not be overlooked. Another type of lens was mentioned, by J. P. Blewett, wherein the field pattern rotates continuously instead of shifting discontinuously in 90° steps. Such a lens might be of interest because of its lack of fringing fields except at its extreme ends.

M. Hildred Blewett
Brookhaven National Laboratory

Bureau of Mines Symposium

On Nonequilibrium Statistical Mechanics

The United States Bureau of Mines is sponsoring a symposium to be held in Pittsburgh on March 23–24, 1953. The symposium is intended to emphasize the more general and fundamental aspects of the statistical mechanics of irreversible processes. Plans are being worked out by a five-man committee whose members are Herbert B. Callen of the University of Pennsylvania, John