per minute, by Ward Leonard voltage control; an additional speed range of from 1000 to 1500 revolutions per minute can be obtained by weakening the motor field.

The coordinated movement in azimuth (about a vertical axis) and elevation (about a horizontal axis) is controlled by signals from an analog computer. The small signals from the computer require amplification at ratios up to 30 million to 1, achieved in the main by direct-coupled amplifiers.

Obviously the design and development of the control machinery at Jodrell Bank was a major task. Requirements were set by the Manchester University staff, under A. C. B. Lovell, and the resulting instrumentation, involving new techniques in electronic and mechanical engineering, was the responsibility of Herman Lindars, managing director of the firm that carried out the work, Dunford and Elliott (Sheffield) Ltd. The Brush Electrical Engineering Company Ltd. was responsible for the manufacture of the machines, motor-control gear, and reduction gear that provide the physical motive power for the telescope.

Basic Facilities

The remote control of the telescope gives it these basic facilities:

1) It can be locked in any given azimuth and elevation.

2) It is capable of continuous motion in azimuth with fixed elevation; or in elevation with fixed azimuth, at any required rate.

3) By coordinating azimuth, elevation, and time, the telescope can be given sidereal motion for following any particular star.

4) It can be set on a predetermined program of search in which it can be left to sweep methodically a given area of the sky.

The computer controlling the electronic-mechanical "engines" which give movement to the telescope is a complex one. While the telescope is capable of movement in only two basic coordinates, to follow a star it is necessary to set up the control in its fixed coordinates, right ascension and declination, and the computer must be capable of translating these into the physical voltage changes that control the driving motors. In order for the telescope to scan across or along the Milky Way, another set of coordinates, galactic latitude and longitude must be employed. Again, it is sometimes necessary to scan in azimuth and elevation and at the same time to read off the positions either in right ascension and declination or in galactic latitude and longitude—or both. The computer, therefore, must be capable of solving, instantaneously and continuously, fundamental equations of spherical trigonometry.

The computer consists of an electrical analog in which magslip resolvers solve the equations by giving output signals proportional to the sine and cosine of the angle through which their rotors are turned. Excitation of the stator windings is given through feedback amplifiers deriving the feedback voltage from auxiliary stator windings. High-gain, two-stage resistance-capacitance-coupled amplifiers obviate nonlinearity in output due to electrical losses and unwanted flux.

No Single Equation

There is no single equation that can be used for control over all parts of the sky. This difficulty is overcome by using 14 different equations in the computer. Cams on the shafts of the resolvers automatically switch in the appropriate equations according to the position in the sky of the target. Seven of these equations are used for calculating azimuth and elevation from hour angle and declination (and vice versa), and another seven serve for calculating latitude and longitude from right ascension and declination.

An additional elevation resolver, set by a calibrated potentiometer on the control desk, is used to correct for parallax error arising when a body near the earth, such as the moon, is observed. The equations for distant targets are computed on the assumption that the viewer is at the center of the earth, while, of course, the telescope is mounted at the earth's periphery. Parallax correction is therefore needed when the viewer is working, as it were, "close up."

Similarity to Television Scanning

When the telescope is required to scan a given area, a "target arc" is selected. As each lateral sweep is completed a pulse can be provided to depress or elevate the arc of scan by a given amount, so that a scanning raster is built up; this is faintly similar to the technique of television scanning, except that the direction of sweep is reversed for each successive line. The raster can be arranged in vertical or horizontal scan and control is fully automatic. The coordinates of the scan can be coupled to a time control that will shift the complete raster in accordance with sidereal time.

In all movements of the telescope, indicator dials show at the control desk the position in which the aerial is firing. Dials indicate degrees and minutes of arc and hours, minutes, and seconds of time. Other dials show sidereal time, universal time, and the repeated-back positions in azimuth and elevation of the telescope itself. This information is given with an accuracy of better than 1 minute of arc.

Sidereal time is obtained by a synchronous motor which is controlled by a regenerative oscillator driving through a power amplifier. The speed of this motor is compared every 30 seconds with a pendulum-driven master clock and the motor is driven at a rate very slightly faster than the required sidereal time would call for. If at the time of the 30-second check the motor-driven clock is in advance of the master clock, a capacitor is switched across the input to V.1, reducing the oscillator frequency and the speed of the sidereal motor to bring the clocks back into coincidence.

J. STUBBS WALKER
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Neurology Federation Opens Office: Neurochemistry Commission Formed

The World Federation of Neurology, which was founded only about 2 years ago, now has a permanent secretariat at 59, rue Philippe Williot, Berchem–Antwerp, Belgium, and a full-time medical executive officer, Charles M. Poser, who is on leave from the University of Kansas. The WFN serves as an information center for world neurology. Its present plans include encouragement of international collaborative studies of neurologic and sensory disorders and establishment of a clearinghouse of information to promote exchange professorships, lectures, and consultancies.

The organization also expects to serve as a focal point for the development of scientific registers and repositories of pathologic specimens and scientific literature. Still other projects include the publication of a world directory of neurologists and neurologic scientists, preparation of a dictionary of neurologic drugs and poisons, compilation of lists of neurologic journals throughout the world, and the maintenance of an up-to-date calendar of national and international neurologic meetings.

The federation is composed of national neurological societies in about 40 countries, which together have approximately 10,000 members. Ludo van Bogaert of the Institut Bunge, Antwerp, is president of the new organization. The other officers are as follows: vice presidents, Macdonald Critchley (Great Britain) and August Tournay (France); secretary-treasurer general, Pearce Bailey (United States); and chairman of the Committee on the Constitution and Bylaws, G. Schaltenbrand (Germany).

Problem Commissions Formed

The WFN has organized several problem commissions to review and evaluate the status of research and research opportunities in specialized areas. These commissions will also study the efficacy of international pooling of scientific talent and facilities for a more effective approach to a given research problem. Ten commissions have already been founded, in the following areas: neuropathology, neurochemistry, comparative neuroanatomy, history of neurology, tropical neurology, child neurology, and neuroanesthesia.

The Neurochemistry Commission is the most recently formed. It met for the first time 29-30 September in Antwerp. Those present were Derek Richter, John Cumings, and Everson Pearse (England); Armand Lowenthal (Belgium); Lars Svennerholm and Gunnar Brante (Sweden); Hans Bauer (Germany); George Edgar (Netherlands); Saul Korey, Jordi Folch-Pi, and Wallace Tourtelotte (U.S.); Judah Quastel (Canada); and Ludo van Bogaert and Charles M. Poser (ex-officio).

Biological Sciences Curriculum Study Formed

The Biological Sciences Curriculum Study, which has headquarters at the University of Colorado, was recently organized by the American Institute of Biological Sciences, with support from the National Science Foundation, to make a broad study of education in the biological sciences at all levels of instruction from elementary grades through the university. In the initial phases of the work, attention will be focused on the secondary school, perhaps the pivotal area in American education today.

The major objectives of the study group, which is made up essentially of an autonomous body of biologists and educators, is to design a coordinated and modern life-sciences curriculum; to recommend a sequence of courses in other subjects of study; and to explore the possibility of designing special courses for exceptional students at all levels. Projects are already being carried out by committees that have been formed in the following areas: course content, innovations in laboratory instruction, teacher preparation, publications, and the gifted student.

Consultants for the curriculum study are engaged in assembling case-histories of a representative group of teachers who are generally recognized to be exceptionally effective, to determine what factors made them successful and to discover any common denominator. The consultants are also preparing a digest of published information on biological science education. In addition, a number of units of course material in biology, teachers' manuals, and laboratory exercises that were prepared during team-coordinated summer writing conferences will be tested and revised for publication. As an aid to in-service teachers, to students, and to laymen interested in biological science, a series of review pamphlets will be issued. A newsletter on the activities of the Biological Sciences Curriculum Study may be obtained by writing to The Director, BSCS, University of Colorado, Boulder.

Science Equipment Purchase Guide

School officials, teachers, and consultants in elementary and secondary schools will find valuable information and direction in the *Purchase Guide for Programs in Science, Mathematics, and Modern Foreign Languages*, recently published by the Council of Chief State School Officers. The 336-page volume contains descriptions of approximately 1000 items of equipment used for instruction in elementary science, mathematics, general science, modern foreign languages, biology, chemistry, and physics. Each description includes an item number, the accepted name of the equipment, a short statement about its possible uses in instruction, and brief specifications as to function, which assist the purchaser in making a selection from among various commercial offerings. A "coding" is also provided for each item to suggest the areas of instruction and the type of course—basic, standard, or advanced—in which the item will be found useful.

Lists of equipment for each of the subjects covered are included in the book to assist purchasers in reviewing their present stocks of equipment. The book also contains "guidelines," short essays on special problems of instruction, and a select list of books and films for each area.

Edgar Fuller, executive secretary of the council, assisted by a seven-member advisory committee, was in charge of the project. The Educational Facilities Laboratories, Inc., provided a major share of the funds.

The *Purchase Guide* may be obtained for $3.95 from Ginn and Company, Statler Building, Boston 17, Mass.

Plant Material Exchange Program Reopened between U.S. and U.S.S.R.

A program for the exchange of plant research materials between the U.S. and the U.S.S.R. has been reactivated this year after 15 years in which there was no official exchange, according to the U.S. Department of Agriculture. The program was revived at the instigation of plant breeders in both countries, some of whom have participated in exchange visits. International exchange of plant materials was begun in 1898 by USDA's Plant Introduction Section, but exchange with Soviet Russia was discontinued about 1944.

Cooperative exchange of new and indigenous varieties of plants between the United States and the U.S.S.R. has proved to be highly beneficial to both countries because of similarities in climate, agricultural interests, and crop problems. Before 1944, U.S. plant breeders received several important types of grasses and alfalfa from Russia; from U.S. contributions under the program, Russia now raises 10 million acres of sunflowers of American origin—a major source of vegetable oil in that country.

Since last March, 577 shipments of forage (grass, legume), oilseed, and small-grain and cereal-crop seeds have been exchanged. Future exchanges this year will include tobacco stock and varieties of fruit, according to H. L. Hyland, supervisor of the exchange program in the United States and head of the Plant Introduction Section of