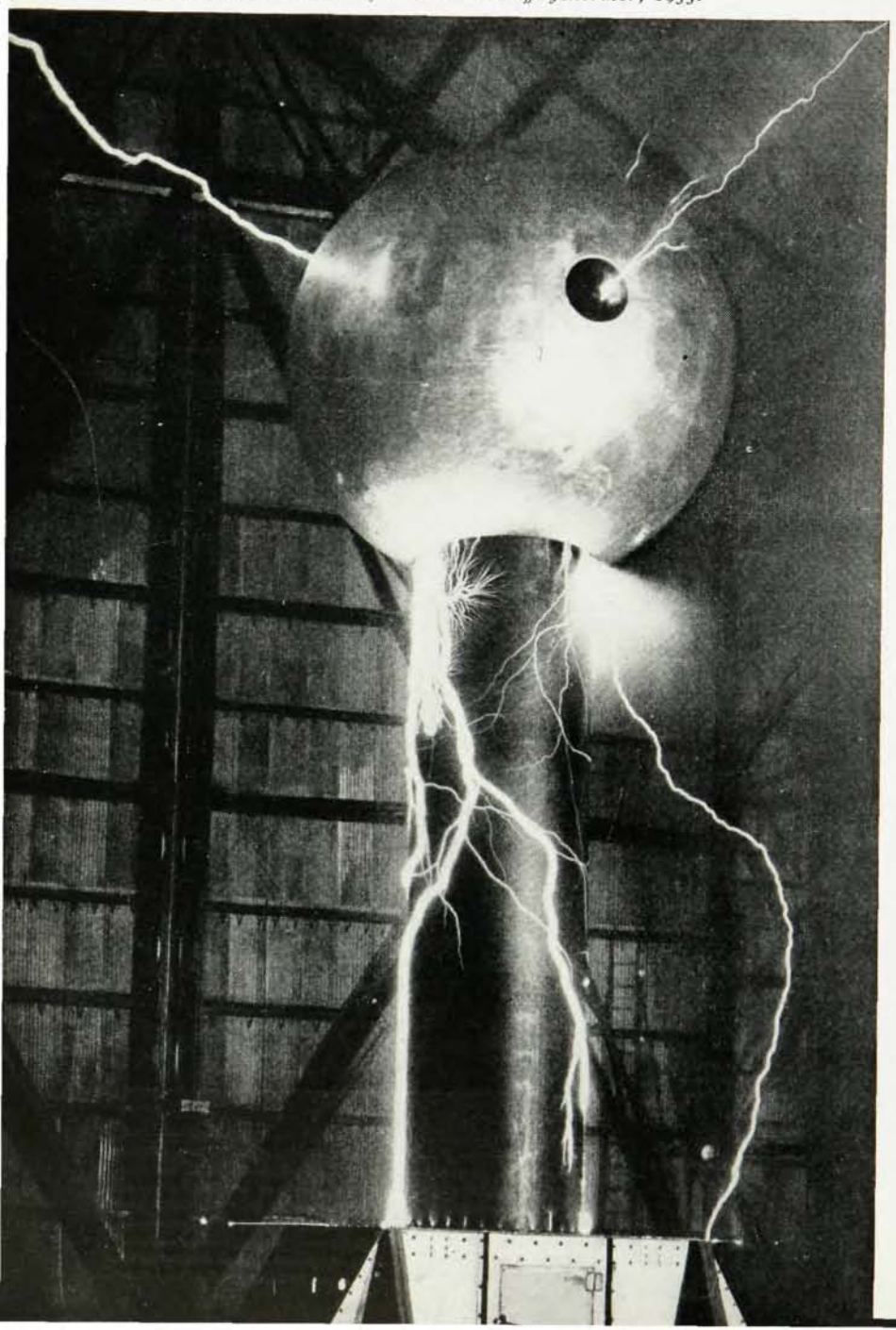
How firm a

First demonstrations of Van de Graaff generator, 1933.



Do physicists care for grants in chunks less than a million dollars at a time? This article grew out of correspondence with the author who wrote to the Institute some time ago expressing his puzzlement that the bulk of grants in aid to scientific research made by Research Corporation has shifted within the last four years from nearly equal numbers in physics and chemistry to a marked preponderance for chemistry. The author speculates on the reason for this and on some of the trends of our changing times in regard to foundation support of research.

by ***Charles H. Schauer***

oundation?

The somewhat supercilious voice from the telephone receiver presumed that the position of the decimal point was a typographical error. In the course of the next day or so, two more voices of varied inflections, representing successively higher echelons in the editorial hierarchy of a popular periodical, raised the same question and accepted assurance with equal reluctance. The difficulty was the record of a Research Corporation grant of $5,000 made to the University of California in 1931 to assist E. O. Lawrence in constructing a cyclotron. From the perspective of 1948 there just weren't enough zeros in this figure for it to be of significance in the same sentence as the word cyclotron.

It is clear in fact and in popular opinion, that as zeros sprout on the figures representing energies proposed for nuclear research, the decimal point of the associated dollars accommodates them by marching from left to right. The great central laboratories, with their high records of achievement, require and receive support of orders of magnitude undreamed of a decade ago. With the step-up from Kev to Mev and from Mev to Bev, the dollars required have increased by powers of ten. Since World War II, government, the only possible source of continuing dollars at the necessary powers of ten, has responded to and in many cases initiated the demands. The wartime activities of the Office of Scientific Research and Development provided the first great impetus to government support of research at academic institutions. The Office of Naval Research has been the principal vehicle for such support in recent years, and under able leadership has contributed greatly to the maintenance of much fundamental research. The Atomic Energy Commission, sometimes working with or through ONR and other groups, has added substantially to the research efforts at academic institutions. Only recently the National Science Foundation has become fact, and its position in and impact upon research can be only speculated about at this time.

While the decimal point has marched to the right, vocabularies have undergone a subtle evolution. Gradually but perceptibly, research at academic institutions has achieved a meaning no longer identical in connotation with the meaning of academic research. The term "contract" in relation to the support of research slowly became synonymous with and has now, in many places, supplanted entirely the word "grant". The term "overhead" has become as vital a part of the lexicon as is "technical assistance".

These changes and evolutions connote an acceptance of research as business, with certain things to be purchased by cash on the barrel head. The fact that the cash frequently fills the barrel makes it big business.

All of this is necessary to the exploration of the important and exciting fields of investigation open to the central laboratory operations with their teams of theoretical and experimental scientists, backed by corps of trained technicians with the current ultimate in instrumentation available to hand. It probably is appropriate that this work carry on at academic institutions of great and growing research tradition as well as at the newer private and government research centers established to supplement available research facilities. The measure of its propriety as academic research may be indicated by the storms of verbiage which have raged during recent years over the relative values of and hypothetical line of demarcation between fundamental and applied research at academic institutions, and government as opposed to private support.

The finely drawn line between academic research and research at academic institutions seems to be where the cleavage occurs, and the field of physics is peculiarly adapted to its graphic illustration. The physicists' historically inalienable right to his screwdriver, the tradition of sealing wax and string, contrast sharply with the massive complexity of the particle accelerator and the physicist's need for 10^x ev energies. The budgets of great central laboratories dwarf the whole operating budgets of many institutions and the operating staffs exceed total members, faculty and students, of many colleges.

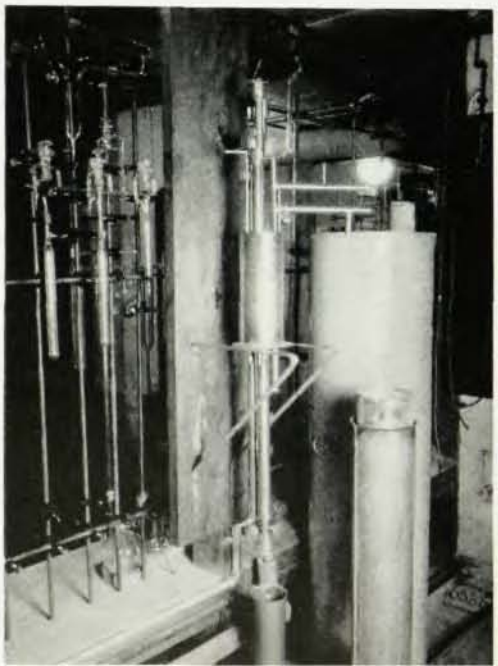
Charles H. Schauer, associate director of the grants in aid of scientific research of the Research Corporation, was assistant chief of the engineering and transition office of the OSRD during the war. The function of that office was to shorten the normal period of time between successful laboratory results of research and its useful field application. This work, Schauer writes, paved the way to his present work with its wide diversity of interests and close ties with the industrial and academic laboratories. In the administration of these grants, Schauer says, there is almost unique opportunity of helping others, in some cases stimulating them to formulate their plans for the direct application of original thought.

The tremendously increased government support of work in this field has been accompanied by a gradual but definite withdrawal on the part of some of the most substantial and time honored private philanthropies. Their great endowments are unable to compete with the government's resources, even if they wished to compete. A recent feature article of *Time* magazine ("Crisis in the Colleges", June 19, 1950) sets forth many of the general aspects of this situation. In one place it reports total gifts and bequests of ninety-three million dollars to fifty-one leading colleges and universities; in another place it sets the cost of the University of California's new cyclotron at ninety-five million dollars. Figures even within an order of magnitude of these are reason for serious question and close examination of policy where there are finite limitations on resources.

Research Corporation is one of the smaller foundations, measured in terms of available resources. It has, however, a history of some thirty-odd years of direct interest in the support of research in the physical sciences and the background of a rather unique program of grants in these fields in the few years since World War II. A brief review of its origin and philosophy may indicate the validity of its more recent experiences as a guide to future policy in the field of physics.

Research Corporation was the brain child of a college professor, Frederick Gardner Cottrell, a physical chemist at the University of California. Around the middle of the first decade of the century he experimented extensively with the idea of electrical precipitation of particles suspended in gases and developed the patentable inventions which resulted in the process of electrical precipitation usually associated with his name. He was of the firm conviction that at least ninety-five percent of every invention was not due to the inventor himself, but that it derived from scientific facts and engineering data which had been determined by previous research in the various allied branches of science and engineering. Accordingly, he was determined not to profit himself from any potential returns on his invention and took steps to see that the returns from the Cottrell precipitation process would be passed on forward to assist other scientists. Research Corporation, a nonprofit organization all of whose net earnings are devoted to the advancement of science and technology, was the result. It was nearly ten years from the time of its incorporation before there were returns on the invention which permitted the support of other research, but since then more than $5,000,000 have been distributed as grants in aid of scientific research to about three hundred institutions, mostly in the United States. The returns from the precipitation process have been augmented by the gifts of other public spirited inventors and by Research Corporation's share of returns on patents managed for some number of academic institutions, but the bulk of the funds has been derived from Dr. Cottrell's original gift.

In the 1920's, Research Corporation funds aided Harvey N. Davis' cryogenic work at Harvard and, through the Smithsonian, Robert H. Goddard's early rocket work. Research Corporation awards for contribution to science recognized the work of Bergen Davis and Werner Heisenberg in this decade. In the 1930's, Research Corporation grants supported Lawrence's early cyclotron work, Van de Graaff's high voltage work, Gibbs and Bacher at Cornell, Bleakney's mass spectrograph work at Princeton, Rabi's molecular beam experiments at Columbia, Aston's low temperature work at Penn State, etc. The emphasis was, as indeed it continues to be under the program of general grants, on the seeking out and support of research of pioneering aspect, work that strikes out from the known boundaries of knowledge rather than that which adds to and fills in the blank spaces within known boundaries.



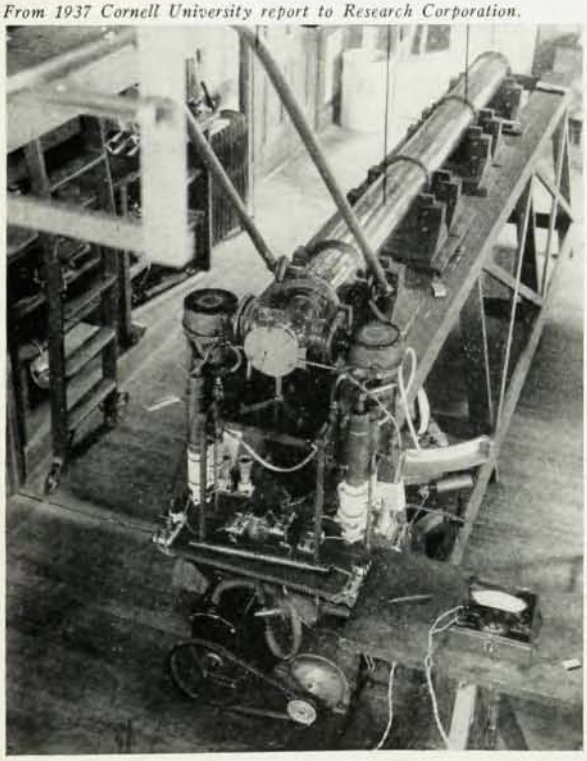
Aston cryostat.

From 1937 Penn State report to Research Corporation.

With the approach and onset of the war, privately sponsored and spontaneous research in the physical sciences essentially ceased to exist. The scientific research talent of the country was absorbed into war research, war industry, and the armed forces and its abilities—and even physical locations—were established and directed to the applied problems of winning the war. The efforts in this direction achieved the spectacular results of creation of the atomic bomb and the approach to useful application of the energy released by nuclear fission. Radar, instruments of destruction, and means of both destroying and maintaining life were developed. However, these achievements were predominately of applied research and extended technology to the edge—and possibly beyond—the solid foundation of basic scientific knowledge. While remarkable new tools for the researcher have developed from these endeavors and tremendous new vistas for investigation were opened, the ability to conduct fundamental research at its normal home, the academic institution, was severely impaired. Laboratory facilities were moved, research teams separated and lines of communication lost or forbidden in the prosecution of the war effort. With the war's end, a long and difficult program of scientific reconversion and rehabilitation faced the academic institutions of the country.

Magnet for Rabi's molecular beam work.
From 1937 Columbia University report to Research Corporation.

Linear accelerator.
From 1937 Cornell University report to Research Corporation.



In recognition of these problems, Research Corporation established a five-year program of special grants in aid of scientific research for which a fund of two and a half million dollars was set aside. Named in honor of Frederick Gardner Cottrell, the postwar grants program was designed primarily to provide incentive for the return to academic pursuits of the younger scientists and technically trained personnel who had been drafted into war research, war industry, and armed forces. The program was announced in October 1945, shortly after the cessation of hostilities, and the plan for assisting smaller colleges and universities in securing assistance and equipment for projects in physics, chemistry, mathematics, and engineering was initiated formally with payment of its first grants early in 1946. As the pertinence of wartime background decreased with time, there was a gradual shift in emphasis to special consideration for the younger men and the smaller and needier institutions.

The overall response to this program of grants has proved in various ways the real need for and the real, as well as intangible, values to be derived from the approach. At the end of its fourth year of effective operation, nearly two million dollars had been applied to the support of some three hundred odd projects in one hundred and ninety-seven different institutions of higher learning, located in forty-five states, the District of Columbia, Puerto

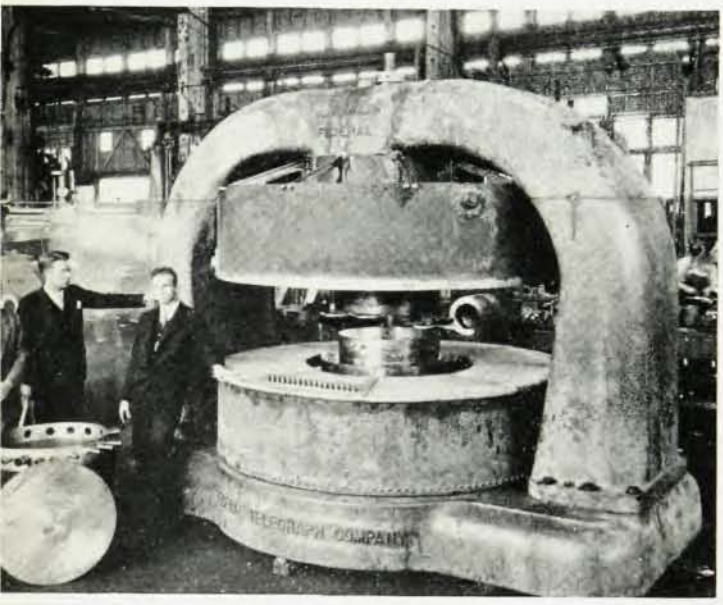
Rico, and Alaska. Individual grants have ranged through three, four, and five figures, and the institutions to which they were made cover the same range in their enrollment figures, although there is no intended or actual correlation in this. Some have been one-shot grants for projects terminated within a year, others have been renewed as many as four times in consecutive years.

We have seen and heard of the lights of midnight oil burning in laboratories previously long dark, in some previously nonexistent. We have observed young scientists, influenced by the possibility of funds for conducting research, join the faculties of small colleges of little or near vanished research tradition and have seen the science curricula revitalized by their presence and their work. There are cases beginning to appear where undergraduates who have been assistants under some of these grants have gone on to advanced degrees and to academic teaching positions and grants from this program for their own work. In four years time there has accumulated in the Research Corporation offices a small but respectable library of scientific publications carrying credit lines for assistance from these grants.

Each of these grants has been based upon application by an individual, or very occasionally jointly by two individuals, for the support of a specific project of his own devising and planning for presentation. Each application had been reviewed and recommended favorably by an Advisory Committee whose membership includes outstanding men in physics, chemistry, mathematics, and engineering who give unselfishly of their time to evaluate these proposals. The work done under these grants is academic research in the truest sense of the phrase.

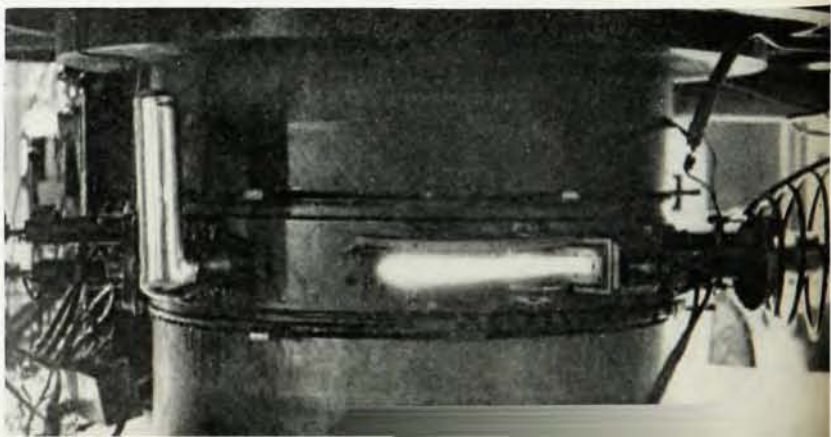
The initial influx of applications following announcement of the program was heavy. There were more than a hundred in the three months following the announcement and nearly two hundred which conformed reasonably as to field of interest within the first year. Physics and chemistry accounted for about forty percent each of the first year's applications, with some fourteen percent in engineering. The physics grants in this period ranged widely, including ionization studies, x-ray crystallography, photoelectric effects, infrared spectroscopy, various low temperature projects, microwave spectroscopy, single crystal studies of various kinds, beta ray spectroscopy, cosmic ray studies, assistance at a modest level on particle accelerators, etc. These grants averaged about $4,000.

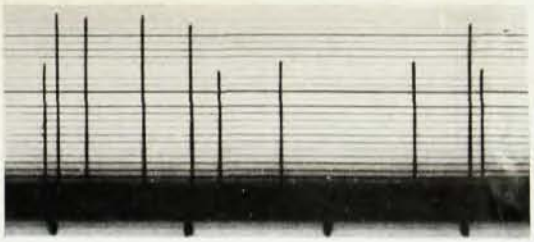
At the start of the fifth year of this program, there were currently active almost three hundred grants, but physics accounted for a bare eighteen percent of the total. During 1949, there were one hundred and thirty grants, exclusive of renewals, made under the program. Nineteen of them were in the field of physics. The decreased number of physics applications and grants has been almost exactly balanced by the increase in chemistry applications and grants, with engineering and mathematics retaining about the same proportionate distribution as they held originally.



Above. Large magnet in Federal Telegraph Company shop. Castings given University of California by Federal Telegraph Company. Funds for completion and installation of the magnet were furnished by Research Corporation. Picture was probably taken in 1931. E. O. Lawrence is in the middle, other two unidentified.

Right. A stream of 5.8 million volt deuterons emerging into the air through a platinum window in the wall of the cyclotron. It is believed to be the first picture of a beam outside the chamber. From 1936 University of California report to Research Corporation.





One of earliest records of energy release in uranium fission. The tall "spikes" on the oscillograph record are the 180 mev uranium fission fragments.

From 1939 Columbia University report to Research Corporation.

High energy uranium fission cloud chamber picture. (Heavy track —the two thin tracks are due to ordinary alpha particles.)

From 1939 Columbia University report to Research Corporation.

An obvious problem arising from this shift in distribution is the progressive malnutrition of the nonchemist members of Research Corporation's Advisory Committee on Grants. Can their digestive systems adapt to the bulk diet of the many syllabled, multipunctuated, terminology of chemistry, or is there something that can or should be done to restore a balance? Possibly it is due entirely to the relative preoccupation of the physicists with the lines of endeavor fed so richly by government funds. It may be that physicists in academic institutions are better off than their chemistry associates and need not seek outside assistance to so great an extent as the latter. There may be speculative chance that the physicists' collective thirst for knowledge has been quenched in recent years to an extent not shared by the chemists.

Has academic research (using the phrase carefully) in the field of physics reached some ultimate plane where only dwindling returns can be achieved with increasingly larger concentrations of effort and expenditures of money? Is the visible future of physics primarily the extension of technology out to the edges of a now near complete foundation of fundamental knowledge? Is there a dearth of physicists with interests other than in nuclear physics and atom smashing? Or is there a dearth of things of interest left to do in general physics? In experimentation other than at seven to eleven figure potentials? Shall private support for research bow to an inevitable requirement that only government can fulfill and seek other outlets that will enable it to make significant contributions?

Some of these questions seem to verge on the ridiculous, but their answers will contribute to the establishment of foundation policy in the field of physics and may well be the double-or-nothing questions on quiz programs of vital concern to public and private scientific and educational institutions. Research Corporation certainly is interested in their answers, in view of its pioneering tradition and its experience of recent years. Presumably the National Science Foundation will need to consider them seriously if its mandate is to be pursued effectively. The Ford Foundation, with its great potential as a source of private support for research, may well have asked and answered by now the questions pertinent to its future operations.

On the basis of the evidence at hand, weighted further by the relative distribution of current publication in the field of physics, it would seem that Research Corporation should begin to look elsewhere for effective operation. In the face of this evidence, Research Corporation maintains a firm faith in the continuing potential of its traditional interest in the field. The basis for the faith lies in its Frederick Gardner Cottrell program of grants, in the undergraduate and graduate students in small colleges who have been and are being touched by the spirit of academic research. It lies with the teachers in these institutions and the stimulation of their quests for knowledge upon those around them. It lies with the administrators of many small colleges and universities who recognize the vitalizing effects upon staff and students of active research interests and with whom we have joined in the planning for establishment of research on a sound basis.

Another two or three years should demonstrate the soundness of this faith. Students who have been touched by these grants will have had the opportunity to go on to their life works, and some professional reputations now just building will be established. How firm a foundation is this for the present faith in the future? The evidence of another academic generation should establish it or wipe it out.