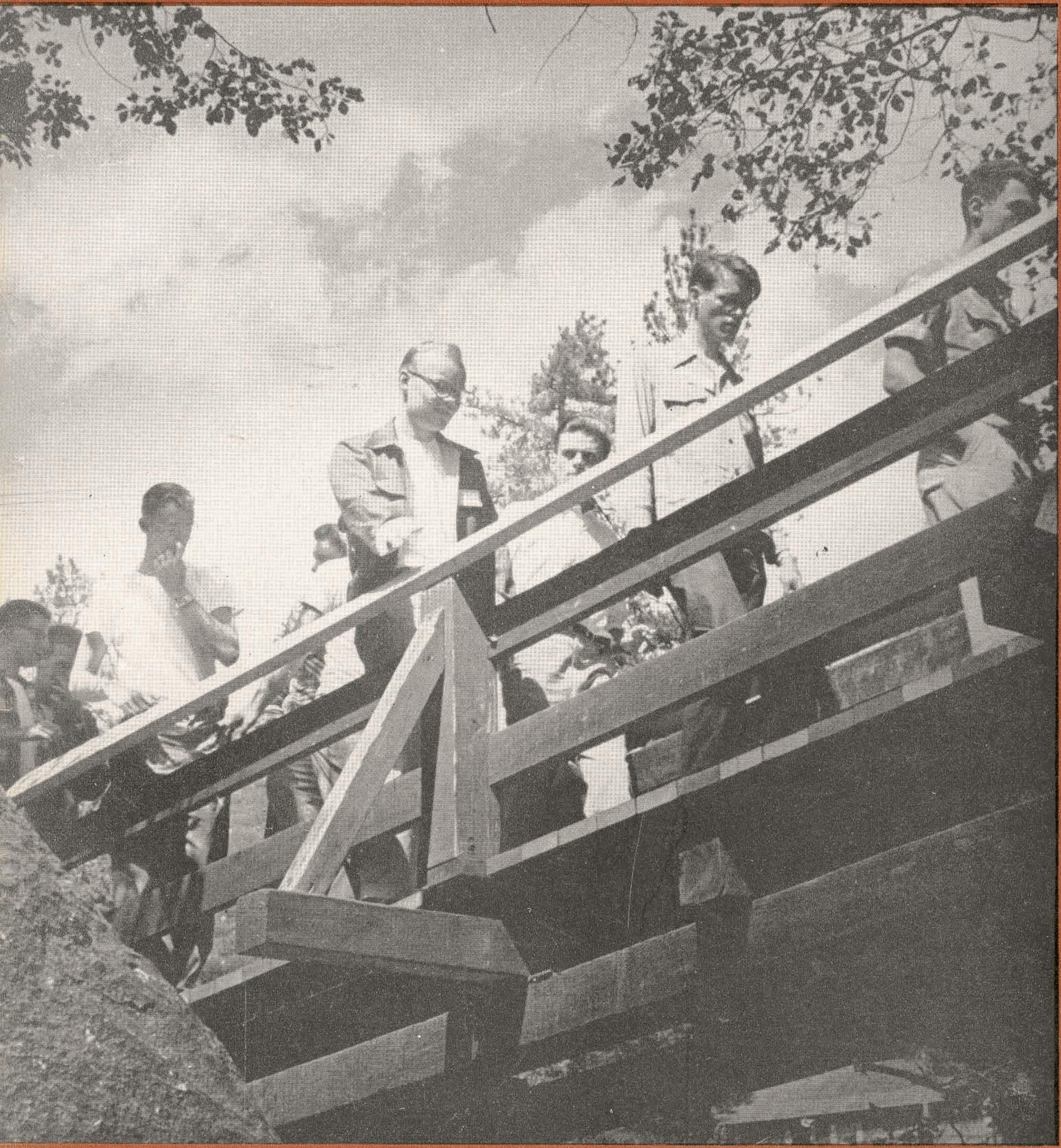
ENGINEERING | AND | SCIENCE

NOVEMBER / 1952



Freshman Camp . . . page 18

PUBLISHED AT THE CALIFORNIA INSTITUTE OF TECHNOLOGY

To keep steel strip on the straight and narrow

. . . at 1000 feet per minute!

● Threading its way through a gigantic continuous-annealing furnace at speeds up to 1000 feet per minute, steel strip behaves erratically. It tends to wander and weave. It fouls the rolls. Sometimes it breaks. Then production on a multi-million-dollar unit, designed for high-speed operation, slows down or stops dead . . . a very costly business.

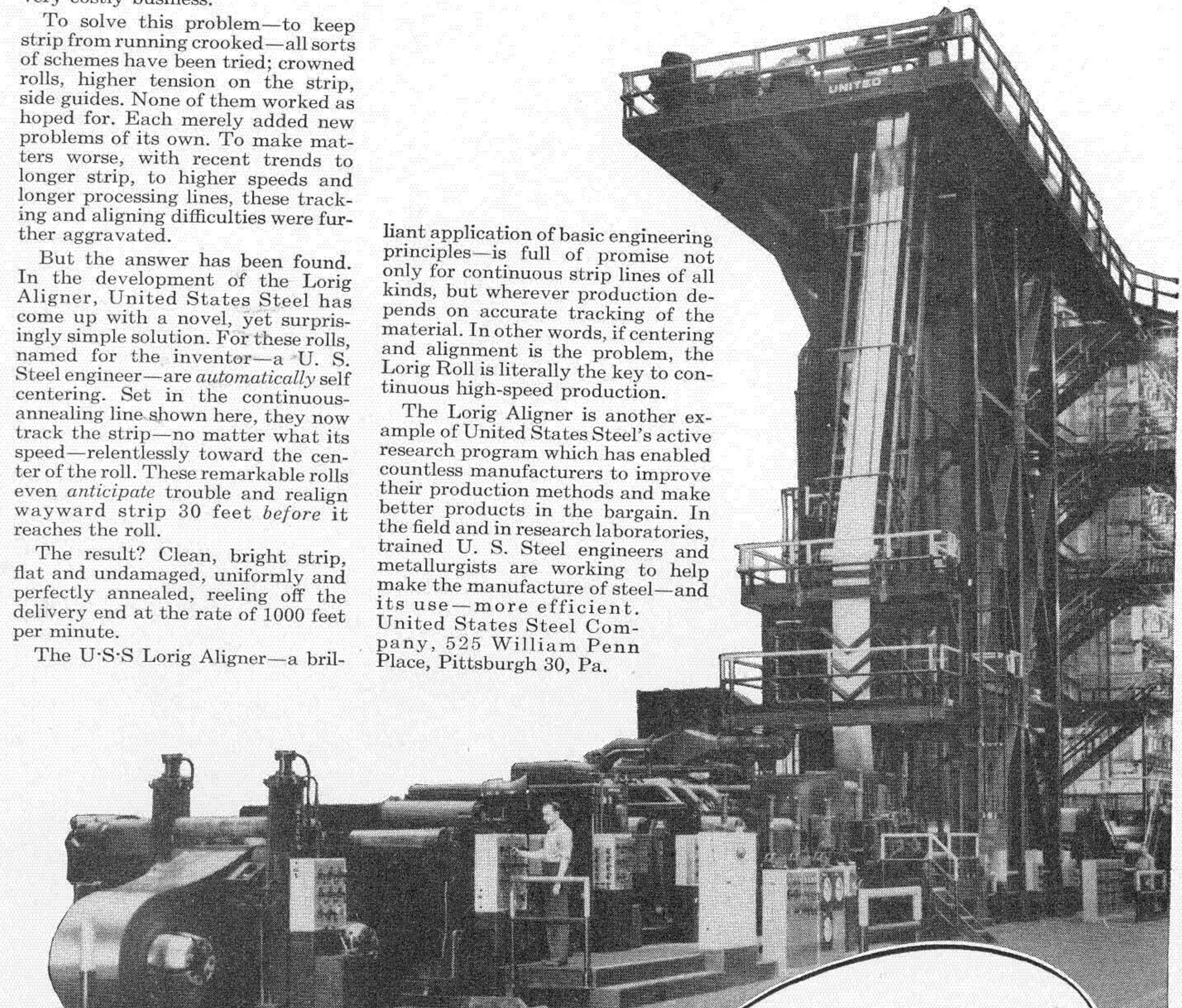
To solve this problem—to keep strip from running crooked—all sorts of schemes have been tried; crowned rolls, higher tension on the strip, side guides. None of them worked as hoped for. Each merely added new problems of its own. To make matters worse, with recent trends to longer strip, to higher speeds and longer processing lines, these tracking and aligning difficulties were further aggravated.

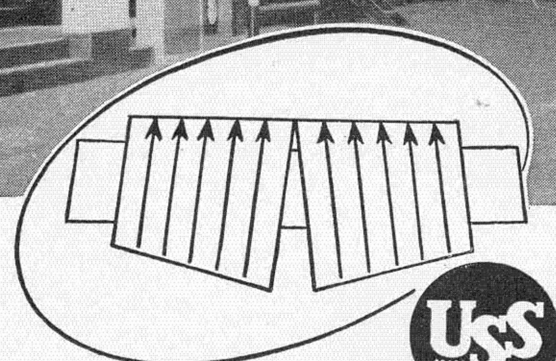
But the answer has been found. In the development of the Lorig Aligner, United States Steel has come up with a novel, yet surprisingly simple solution. For these rolls, named for the inventor—a U. S. Steel engineer—are *automatically* self centering. Set in the continuous-annealing line shown here, they now track the strip—no matter what its speed—relentlessly toward the center of the roll. These remarkable rolls even *anticipate* trouble and realign wayward strip 30 feet *before* it reaches the roll.

The result? Clean, bright strip, flat and undamaged, uniformly and perfectly annealed, reeling off the delivery end at the rate of 1000 feet per minute.

The U·S·S Lorig Aligner—a brilliant application of basic engineering principles—is full of promise not only for continuous strip lines of all kinds, but wherever production depends on accurate tracking of the material. In other words, if centering and alignment is the problem, the Lorig Roll is literally the key to continuous high-speed production.

The Lorig Aligner is another example of United States Steel's active research program which has enabled countless manufacturers to improve their production methods and make better products in the bargain. In the field and in research laboratories, trained U. S. Steel engineers and metallurgists are working to help make the manufacture of steel—and its use—more efficient. United States Steel Company, 525 William Penn Place, Pittsburgh 30, Pa.





THE U·S·S LORIG ALIGNER consists of a divided roll (conical effect exaggerated at the right) with each conical half running on a common rotating axle that is slightly deflected in the center so that the upper surfaces of the cones form a straight surface. As the strip passes over the roll, strongly converging lateral forces are set up to exert a powerful centering action on the strip that immediately corrects any deviation and keeps the strip running straight and true.

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a real challenge!

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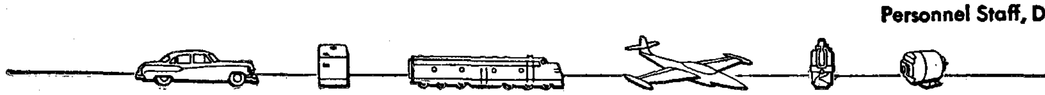
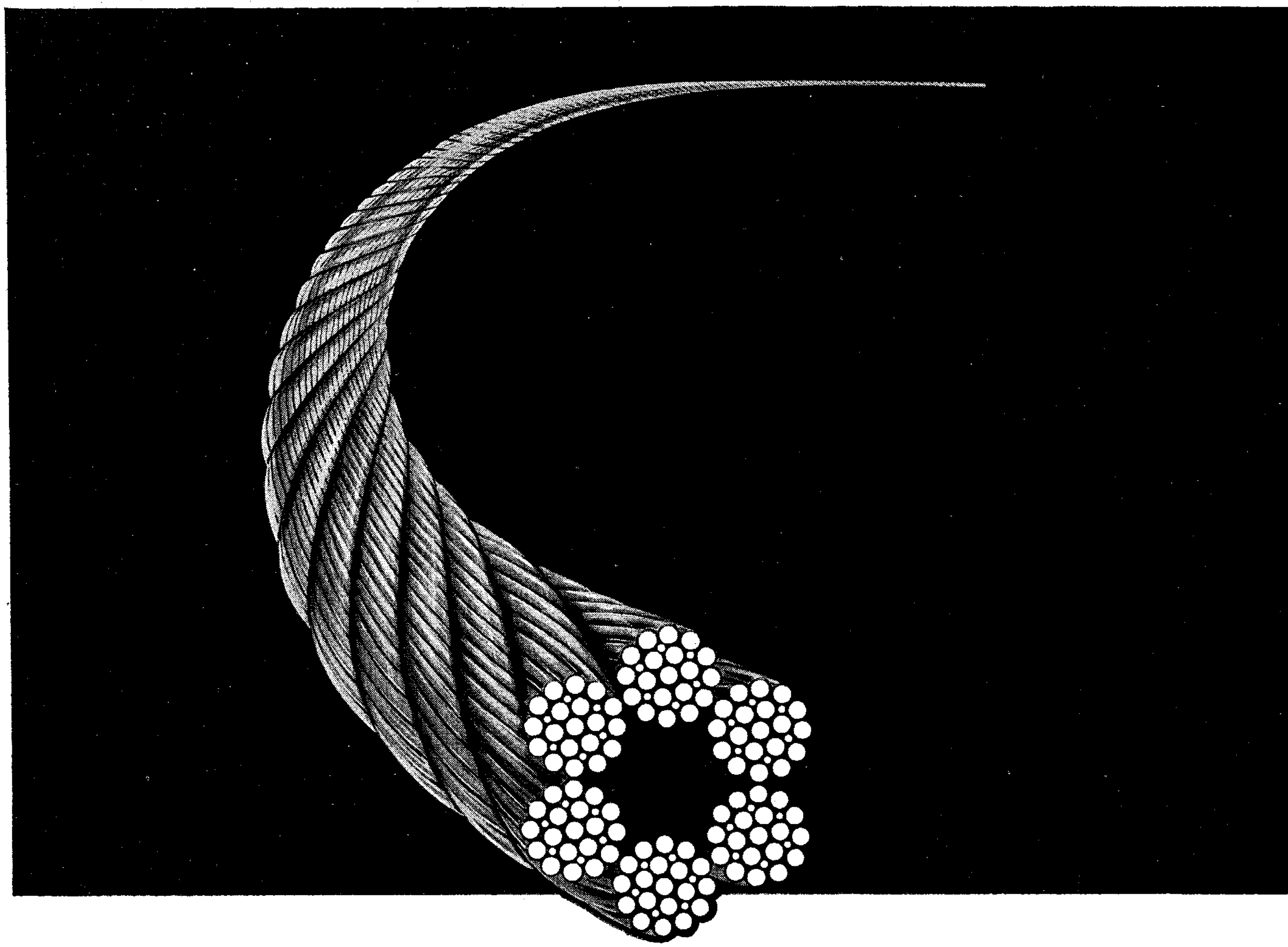
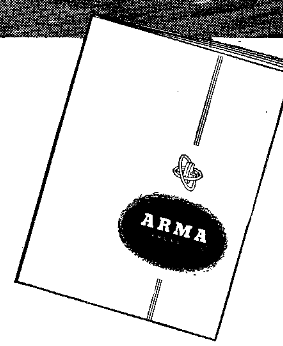




"On Target" Today demands electronic computations



Today's gunnery is a far cry from the days of slugging it out at close range — it demands split-second solutions to constantly varying, increasingly complex mathematical problems. Only continuous engineering advances in electronic instrumentation can accomplish this feat.

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ENGINEERING AND SCIENCE

NOVEMBER 1952 VOLUME XVI NUMBER 2

PUBLISHED AT THE CALIFORNIA INSTITUTE OF TECHNOLOGY

IN THIS ISSUE

This month's cover, we think, is an impressive and symbolic shot of some of the members of the class of '56, bravely striding across the bridge of the future. In actual fact, however, they are merely crossing the bridge that leads to the dining hall at Freshman Camp. For more on this year's Camp, see page 18.

Lawrence C. Widdoes, author of "Electric Power from Nuclear Energy" on page 9 of this issue, graduated from Caltech in 1941 as an applied chemist. He was a torpedo officer in the Navy from 1945-47, got his M.S. at the University of Michigan in 1947, worked for the National Dairy Research Labs until 1950, then went to the Oak Ridge School of Reactor Technology. He joined the Monsanto Chemical Company in 1951, just as the Atomic Electric Project described in his article was getting under way. Right now he's a senior engineer on this team of five nuclear engineers and three electric utility specialists, which acts as an advisory and evaluation group on atomic energy for the co-sponsors of the Project—Monsanto and the Union Electric Co.

"**The Diamat** and Modern Science" by Paul S. Epstein (page 23) was originally presented at the 1951 meeting of the Congress for Cultural Freedom in Strasbourg, France. It has also appeared in the *Bulletin of Atomic Scientists* (August, 1952).

PICTURE CREDITS

Cover	William V. Wright
p. 18, 19,22	William V. Wright
p. 48	Jeff Littleboy
	Pasadena Star-News
p. 44	William V. Wright

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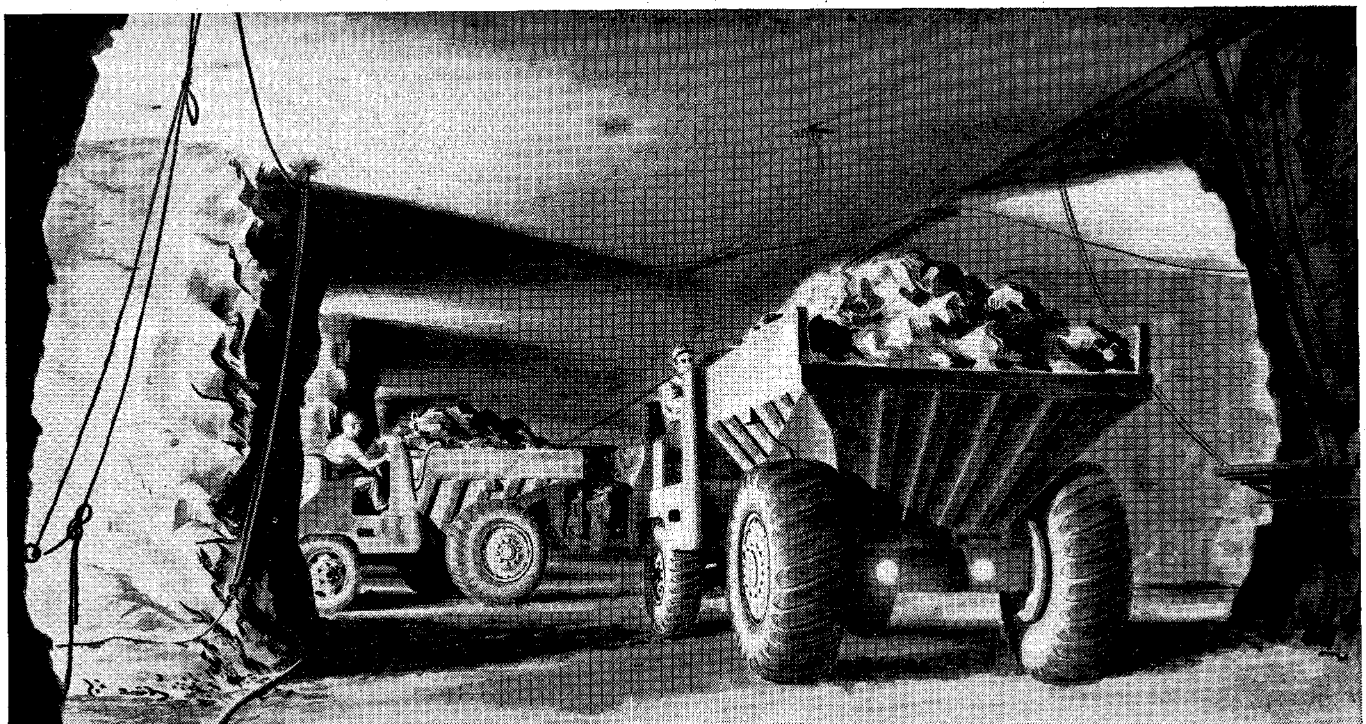
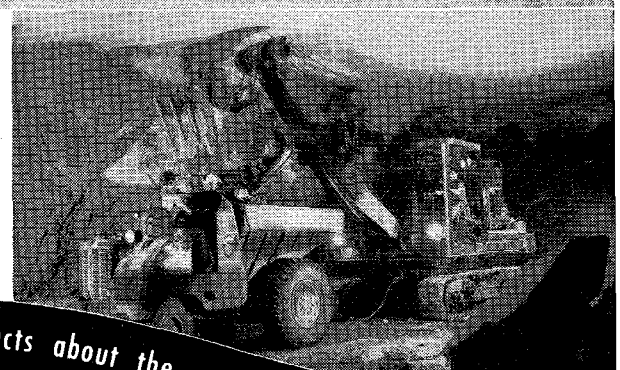


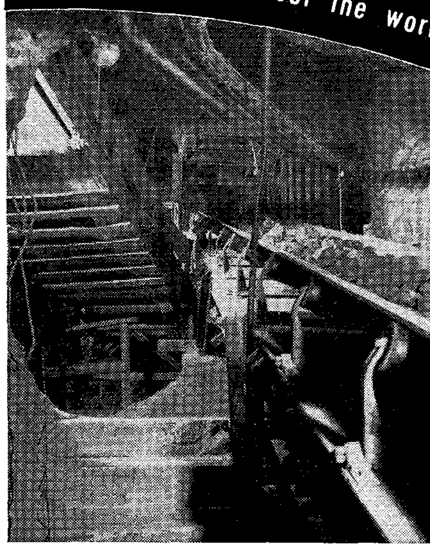
They drive along streets 2200 feet underground

Big, rugged Diesel-powered trucks roll along corridors as wide as average city streets in the world's deepest limestone mine. This Columbia-Southern project—located almost directly beneath its plant at Barberton, Ohio—assures a steady flow of this basic raw material for the manufacture of alkalies by augmenting supplies from other sources.

This unique operation is but one of many developments pioneered by Columbia-Southern to improve production of alkalies and related chemicals and to serve industry more efficiently from plants located at Corpus Christi, Texas . . . Lake Charles, Louisiana . . . Natrium, West Virginia . . . Barberton, Ohio . . . Bartlett, California.



Interesting facts about the world's deepest limestone mine



Massive equipment of modern design—capable of moving 300 tons of stone per hour—was assembled underground. Shovels are 1½ yard, electrically powered.

Limestone is crushed and screened, then brought to the surface by a semi-automatic hoist which attains a speed of 2,000 feet per minute and automatically brakes and dumps at the top.

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ELECTRIC POWER FROM NUCLEAR ENERGY

Commercial production of electric power from nuclear fuel is on the way. Shall we wait for the day when we learn how to make electric power alone in an atomic reactor — or enter the field now by co-producing plutonium and power?

By LAWRENCE C. WIDDOES

LAST JANUARY, the Atomic Energy Commission announced that at Arco, Idaho, electric power had been generated from nuclear energy. This was the first authentic record of such an achievement. In February, President Truman revealed that a nuclear-powered engine for the submarine *Nautilus* was under construction. In June, the Monsanto Chemical Company and Union Electric Company of Missouri recommended that the AEC start the design and development work necessary to construct a plutonium-power pilot plant reactor.

Obviously, commercial production of electric power from nuclear fuel is on the way. Because of the economics involved, it does not seem likely that earlier predictions of large-scale production of electric power alone from a nuclear reactor will be realized in the near future. On the contrary, the first large-scale electric power will probably be a co-product of the manufacture of plutonium.

In the field of atomic energy, we might say that we are in a plutonium economy. The government is most anxious to increase its ability to stockpile plutonium. Since it appears technically feasible to produce plutonium and power simultaneously, the economics of the situation seems to dictate that this method be tried first. Ultimately—perhaps after a decade spent in improving our technology—it may be possible to build nuclear reactors producing only electricity, and to operate them in competition with coal-fired plants.

The proposed method of producing both plutonium and electric power is perhaps better understood against the background of plutonium production. Plutonium is made in a nuclear reactor containing a combination of U-235 and U-238. The neutrons required for plutonium production come from the fission of a U-235 nucleus. The resulting fission fragments have an enormous kinetic energy which eventually must be removed from the reactor as heat.

The reactors at Hanford, Washington, used for the production of plutonium, were an epic achievement. After 10 years they are still invaluable as producers of plutonium. Ten years ago, the demand for plutonium was paramount; no time was wasted in the atomic race with the Germans in an attempt to produce useful power. In the interest of making plutonium, the heat from the Hanford reactors is removed at such a temperature level that it is thermodynamically and economically impractical to use this energy to run a steam turbine and produce electricity.

In studying the practicability of producing electric power from nuclear fuel, the question arises: If new plutonium production reactors were to be built today, could they be designed so that the heat energy could be economically converted to electrical energy—thereby decreasing the cost of plutonium?

Since a great deal of heat is released in the production of a unit of plutonium, it appears simple, at first consideration, to remove this heat at a temperature sufficiently high to produce economical power. After all, with the Idaho power experiments and the Navy's plans for nuclear-powered submarine engines as far advanced as they are, one would think that the problem of converting nuclear energy to economic power would be easy. Though the technical information obtainable from these two developments will be invaluable, the fact remains that one is designed primarily to determine the technical feasibility of breeding—while the other is designed as a military power source. (A breeder, loosely defined, is a reactor which produces more fissionable material than it consumes.)

About 24,000 kw hours of heat energy are released when one gram of U-235 is fissioned. This is the equivalent to the combustion of about 3.3 tons of coal. At *current market prices* the heat from this amount of coal is worth about $20. On the other hand, the value of the plutonium produced when this gram of U-235 is fissioned—measured in terms of a military explosive—must certainly be far greater than $20. Thus, if removing the heat energy from the reactor at a high temperature causes an appreciable decrease in its plutonium output, then the decision to produce power faces serious economic problems.

Indeed, this problem of high temperature heat versus plutonium production is one of the more serious problems facing the designer of a dual purpose plutonium-power reactor today.

Take, for example, a hypothetical metallic uranium fuel element surrounded by a hypothetical coolant. With known materials of construction, there obviously exists a certain upper limit on the fuel temperature. Just as obvious is the fact that the colder the coolant, the larger the over-all temperature gradient between the limiting temperature of the fuel and the bulk temperature of the coolant. Since the rate of heat removal and, therefore, the rate of plutonium production is proportional to the over-all temperature difference, the colder the coolant, the greater the plutonium production. But cold coolants simply do not make good heat sources for steam electric plants.

Recommendation to the AEC

Although it appears that there are other problems as well, it does seem to be possible to produce plutonium and electric power in the same reactor without sacrificing plutonium production. In 1951, the AEC signed one-year contracts with four industrial groups for a feasibility study of the problem of simultaneously producing electric power and plutonium. One of these groups was the joint Monsanto-Union Electric team. At the end of the year's study, this team felt that a solution was possible, and recommended that the AEC start the design and development work necessary to build a pilot plant which would fill in some remaining gaps in the technology.

In resolving the conflict between the temperature of the coolant and the rate of plutonium production, some technical factors have been agreed upon. Since all reactor coolants and their containers are to some extent neutron absorbers, the neutron economy in the reactor tends to decrease as the volume of coolant associated with a given volume of fuel is increased. Thus, even though the reactor may run faster with a colder coolant, it does not necessarily run as efficiently.

Obviously, therefore, there is some optimum cross-sectional coolant area to be associated with a given area of fuel to provide the maximum plutonium production in a given reactor. The hope for electric power and plutonium co-production in the near future lies in fuel elements which can develop such a high specific power that, even though plutonium production is maximized, the outlet coolant is hot enough so that at least part of the heat energy can be skimmed off to produce electrical power.

The solution of technical problems is not the final hurdle which must be crossed. A large-scale plutonium-power producer must fulfill certain other requirements before private enterprise will be willing to invest the necessary capital. The nuclear power plant must compete with many other attractive investments. The production of power and plutonium must not only promise a reasonable profit during the plutonium economy; it must show promise of a profitable future beyond any period of military demand for plutonium.

If it is possible to build a dual purpose reactor which maximizes plutonium production, reduces unit costs below the Hanford level, and still permits power production, it would appear that the larger part of the high capital loading would be charged to the plutonium production.

The capital involved here would be that amount required to build a nuclear reactor and heat-dump system designed for production of plutonium alone. The incremental capital required to add more heat-exchanger area and a turbo-generator would be charged against the electricity produced. Furthermore, it would seem fair to amortize both sections of the plant over the period during which plutonium would be sold to the government. Operating costs also could be fairly apportioned between the two products in a similar manner.

With the incremental capital chargeable to power production less than the capital normally necessary for a complete coal-fired steam electric plant and with heat almost free, low cost power could be had if the amortization period were comparable to normal utility practice.

The capital charges per kilowatt hour in a coal-burning plant are usually based on a 35-year amortization schedule. Because of the uncertainty in the market for plutonium—and since there is no assurance that the nuclear-fired plant will last for 35 years—the atomic power complex must be amortized over a more conservative period, variously estimated from five to ten to fifteen years.

As the amortization period is reduced in the nuclear plant, there is a point when the increased capital charges completely offset even free heat, and it costs as much to produce power as it would in a coal-fired plant. Therefore, if the power from a plutonium-power complex is to be competitive with power from coal-fired stations, a firm contract for military plutonium over a certain minimum period of time appears to be necessary.

When the military requirements for plutonium have been met, it is conceivable that an even greater demand for plutonium to be used as a nuclear fuel may develop—but, of course, at a much lower price. Because of its nuclear characteristics, it is possible that plutonium could be used to fuel a fast breeder and, through these breeders, it is possible that our entire supply of U-238 could be converted into fissionable material, increasing the fuel resources of the world by a large factor.

When this power economy commences, if these dual-purpose plutonium-power producers have useful life left, the question arises as to whether they can compete with coal-fired plants or with the more improved types of reactors which surely will be built in the future.

No plutonium-power complexes have been built to date. Therefore, no really reliable cost comparison between reactors and coal-fired plants can possibly be made, because of lack of basic data. On the basis of the past performance of the chemical industry, it seems probable, however, that fuel and operating costs of the twin-purpose reactor can be appreciably reduced after a few years' experience has been gained. If this can be done, then the *amortized* plant can probably compete in the production of both power and nuclear fuel with almost any plant (coal-fired or nuclear) which can possibly be conceived today.

Another hurdle for the eventual private production of plutonium and power may possibly be the Atomic Energy Act of 1946. Section 4(b) of the Act seems to prohibit private ownership of facilities for the production of fissionable material in the quantities and in the size contemplated in discussion of even pilot plant units. If it is determined that this prohibition in fact exists, then it would be necessary for the Congress to pass the necessary enabling legislation which would, of course, require that the safety and security controls remain completely within the jurisdiction of the government, with adequate policing powers so that no threat would exist to our nation's security from such private ownership.

Additionally, it appears that this same Act reserves exclusively to the government all patents and inventions in the field of atomic energy. Section 11(a) (2) says:

"No patent hereafter granted shall confer any rights with respect to any invention or discovery to the extent that such invention or discovery is used *in the production of fissionable material or in the utilization of fissionable material* or atomic energy for a military weapon. . . ."

The italicized phrases in this quotation from the law indicate the area of concern in this discussion of patents. Admittedly, patents and inventions dealing solely with the utilization of atomic energy for military purposes must remain the exclusive property of the government.

While it is understandable that such a law should have governed during times when almost all inventions were obtained at government expense, it seems that with the approaching possibility of major industrial programs in the field of atomic power, a review of such policy is in order.

Patent protection

Eminent patent attorneys who have been closely associated with the atomic energy program argue that the patent section of this law should be overhauled to give maximum encouragement to the industrial development of atomic power reactors. They feel that the traditional method of encouraging inventive genius through reward in the form of protection to the inventor must be retained if we are to make sufficient progress with the development of atomic energy in its peace-time applications. It is doubtful that many companies will invest money, time, and talent, unless there is the patent protection for any inventions that they may achieve through research and development to apply atomic reactors as direct tools and aids for use in industry.

Electric power is a keystone of industrial expansion in this country. We are using our reserves of gas, petroleum, and coal, at an ever increasing rate. Indeed, some experts feel that we might conceivably deplete our power fuel reserves seriously by the end of this century. We do not yet possess sufficient technology to draw on the solar energy which appears to be the world's ultimate and only long-term fuel source—but there is no doubt that eventually this technology will come.

We should be prepared, however, for an era in which our conventional fuels become more scarce and expensive—and perhaps before we learn how to utilize solar energy. The hope for this era is nuclear power.

We can enter the field of nuclear power now by co-producing plutonium and power, or we can wait for the day when we learn how to make economic power alone in an atomic reactor. Entering the field now will result in a significant advance in the technology within the next four to six years. It will give us full-scale operating plants from which we can derive accurate capital and operating costs. In short, it will hasten the day when industry will have the confidence and know-how to construct atomic power complexes which will be competitive with coal-fired sources.

While we do not achieve the ultimate by producing both plutonium and power, we significantly advance the technology and help to add to the urgently required stockpile of plutonium.

Dr. William B. Munro (right), Caltech Professor Emeritus of History and Government, and Robert O. Schad, Curator of Rare Books at the Huntington Library, look over the Munro collection of election ballots which were on exhibit at the Huntington Library this fall.

ON THE BALLOT

Dr. William B. Munro, Caltech's Professor Emeritus of History and Government, and Treasurer of the Board of Trustees, is a collector of election ballots. As an indication of how unique a hobby this is—in all the years that he's been tracking down old ballots, Dr. Munro has never come across another collector in the field.

His collection includes ballots from all over the world, including some from Persia, Peru, China and Greece. Most of the ballots, however, are from the United States—and the Munro collection graphically demonstrates the development of our election procedures.

More ballots have been printed in the United States than in any other country in the world; and more experiments with different types of ballots have been tried here than anywhere else. Still, the ballot is just about the most ephemeral piece of printed matter imaginable. It's against the law for an election officer to give one out before election. After election, unused ballots are usually destroyed, while used ones are locked up in case of a recount.

National election ballots prior to the Civil War are especially rare in this country, though occasionally one still turns up in some old family papers. The oldest presidential ballot in the Munro collection is an 1840 one, used to cast a vote for Martin Van Buren.

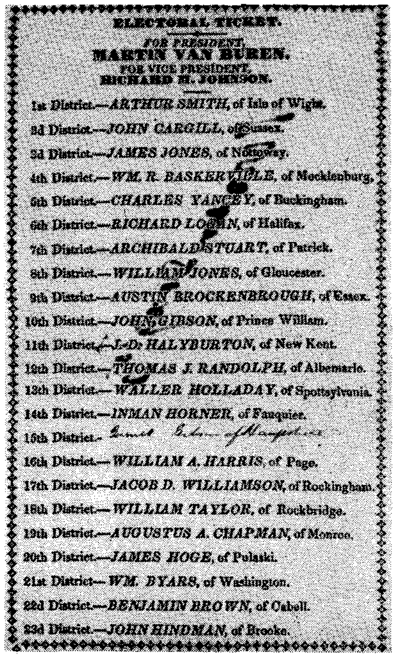
Printed ballots weren't used in the United States until at least late in the 18th century, and there doesn't seem to be any reliable record of when they first appeared.

The earliest elections in this country, in Massachusetts, were held in town meetings, and votes were taken by a show of hands. A little later some towns began to use the "corn and bean" ballot. Voters who attended town meetings each received one grain of corn and one black bean. When a candidate was nominated for the Great and General Court, the ballot box was passed. If, on inspection, it contained more grains of corn than it did black beans the candidate was elected. The Massachusetts Historical Society still elects members by the corn and bean system.

Though written ballots were sometimes used even in Colonial days, no official ballots were printed until long after the Civil War. Each party had its own ballot, with its slate printed on it. Sometimes these ballots contained only the presidential and vice-presidential candidates' names, with those of the electors pledged to them.

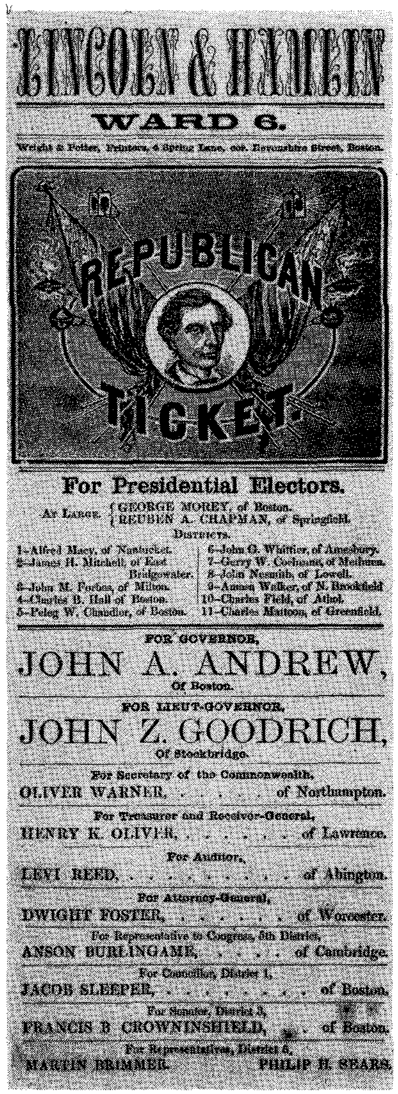
Prepared by the party, the ballot was mailed to the voter, or thrust into his hands as he approached the polling booth on election day. This made it easy to "stuff the ballot box," since anyone with a mind to could put more than one ballot in the box.

No strict count was kept of the used and unused ballots. There was no "X" to be marked on the ballot. It was just dropped into the box, or, in some cases, was first signed on the back by the voter. If the voter wanted to vote the straight ticket, he used the ballot as it was; if any of the candidates didn't please him,


ELECTORAL TICKET.
FOR PRESIDENT,
MARTIN VAN BUREN.
FOR VICE PRESIDENT,
RICHARD M. JOHNSON.
1st District.—ARTHUR SMITH, of Isle of Wight.
2d District.—JOHN CARGILL, of Sussex.
3d District.—JAMES JONES, of Nottoway.
4th District.—WM. R. BASKERVILLE, of Mecklenburg.
5th District.—CHARLES YANCEY, of Buckingham.
6th District.—RICHARD LOGAN, of Halifax.
7th District.—ARCHIBALD STUART, of Patrick.
8th District.—WILLIAM JONES, of Gloucester.
9th District.—AUSTIN BROCKENBROUGH, of Essex.
10th District.—JOHN GIBSON, of Prince William.
11th District.—L. D. HALYBURTON, of New Kent.
12th District.—THOMAS J. RANDOLPH, of Albemarle.
13th District.—WALLER HOLLADAY, of Spottsylvania.
14th District.—INMAN HORNER, of Fauquier.
15th District.— [illegible]
16th District.—WILLIAM A. HARRIS, of Page.
17th District.—JACOB D. WILLIAMSON, of Rockingham.
18th District.—WILLIAM TAYLOR, of Rockbridge.
19th District.—AUGUSTUS A. CHAPMAN, of Monroe.
20th District.—JAMES HOGE, of Pulaski.
21st District—WM. BYARS, of Washington.
22d District.—BENJAMIN BROWN, of Cabell.
23d District.—JOHN HINDMAN, of Brooke.

1840

This is the earliest ballot in the Munro collection, and the ink signature written across its face indicates it was used to cast a vote for Van Buren and Johnson, running on the Democratic ticket—against William H. Harrison and John Tyler, on the Whig ticket. Van Buren and Johnson headed a winning ticket in 1836, but in 1840 they were defeated by "Tippecanoe and Tyler too."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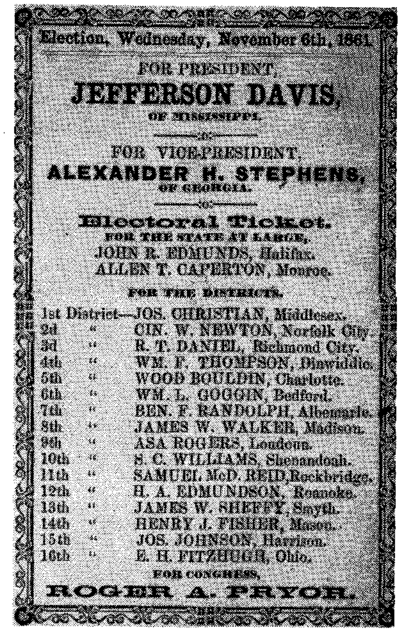
REPUBLICAN TICKET.
For Presidential Electors.
AT LARGE. { GEORGE MOREY, of Boston. / REUBEN A. CHAPMAN, of Springfield.
DISTRICTS.
1–Alfred Macy, of Nantucket.
2–James H. Mitchell, of East Bridgewater.
3–John M. Forbes, of Milton.
4–Charles B. Hall of Boston.
5–Peleg W. Chandler, of Boston.
6–John G. Whittier, of Amesbury.
7–Gerry W. Cochrane, of Methuen.
8–John Nesmith, of Lowell.
9–Amasa Walker, of N. Brookfield
10–Charles Field, of Athol.
11–Charles Mattoon, of Greenfield.
FOR GOVERNOR,
JOHN A. ANDREW,
Of Boston.
FOR LIEUT-GOVERNOR,
JOHN Z. GOODRICH,
Of Stockbridge.
For Secretary of the Commonwealth,
OLIVER WARNER, ... of Northampton.
For Treasurer and Receiver-General,
HENRY K. OLIVER, ... of Lawrence.
For Auditor,
LEVI REED, ... of Abington.
For Attorney-General,
DWIGHT FOSTER, ... of Worcester.
For Representative to Congress, 5th District,
ANSON BURLINGAME, ... of Cambridge.
For Councillor, District 1,
JACOB SLEEPER, ... of Boston.
For Senator, District 3,
FRANCIS B CROWNINSHIELD, . . of Boston.
For Representatives, District 8,
MARTIN BRIMMER. PHILIP H. SEARS.

1860

In this year Abraham Lincoln and Hannibal Hamlin, on the Republican ticket, defeated Stephen Douglas and Herschel Johnson, Democrats—as well as the candidates of the Southern Democratic Party and those of the Constitutional Union Party. Note on the ballot that Lincoln is clean-shaven. By inauguration day in 1861 he had grown the beard which he wore for the rest of his life.


Election, Wednesday, November 6th, 1861.
FOR PRESIDENT,
JEFFERSON DAVIS,
OF MISSISSIPPI.
FOR VICE-PRESIDENT,
ALEXANDER H. STEPHENS,
OF GEORGIA.
Electoral Ticket.
FOR THE STATE AT LARGE,
JOHN R. EDMUNDS, Halifax.
ALLEN T. CAPERTON, Monroe.
FOR THE DISTRICTS.
1st District—JOS. CHRISTIAN, Middlesex.
2d " CIN. W. NEWTON, Norfolk City.
3d " R. T. DANIEL, Richmond City.
4th " WM. F. THOMPSON, Dinwiddie.
5th " WOOD BOULDIN, Charlotte.
6th " WM. L. GOGGIN, Bedford.
7th " BEN. F. RANDOLPH, Albemarle.
8th " JAMES W. WALKER, Madison.
9th " ASA ROGERS, Loudoun.
10th " S. C. WILLIAMS, Shenandoah.
11th " SAMUEL McD. REID, Rockbridge.
12th " H. A. EDMUNDSON, Roanoke.
13th " JAMES W. SHEFFY, Smyth.
14th " HENRY J. FISHER, Mason.
15th " JOS. JOHNSON, Harrison.
16th " E. H. FITZHUGH, Ohio.
FOR CONGRESS,
ROGER A. PRYOR.

1861

A rare item in the Munro collection—the ballot naming Jefferson Davis as the unopposed candidate for the presidency of the Confederate States of America.

he could "scratch the ticket" by crossing out names and substituting others.

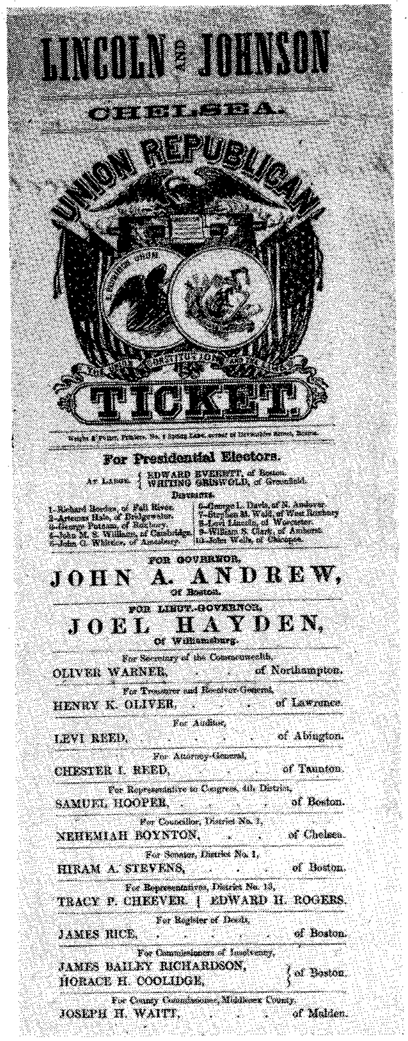
It wasn't until the late 1880's that the Australian ballot came into use here. Politicians contemptuously referred to it as the "Kangaroo ballot" when it was first introduced from Australia. It was the first American ballot requiring a voter to mark a cross, but its most distinguishing feature was that it was *official*—printed by the election authorities, and not by the political parties.

The largest ballot in the Munro collection is one for the 23rd Assembly District in the New York State primary election of March 26, 1902. It is 14 feet long.

A slightly smaller ballot, used in Yankton County, South Dakota, measures 8 feet, 3 inches. It contains the complete text of several statutes, including one on the reorganization of the South Dakota National Guard. It is set in 7 point type (three sizes smaller than what you are now reading). It contains 4-feet-square of reading matter. And it is mentioned here to give courage to Californians facing a ballot containing 24 propositions on November 4.

1864

In this year Abraham Lincoln and Andrew Johnson ran on the Republican ticket, against George B. McClellan and George H. Pendleton, Democrats. Note, in the ballots of the two parties at the left, that the Republican ballot lists a full slate of candidates, while its ornate Democratic counterpart leaves it to the discretion of the voter to write in his own candidate for five county offices.



LINCOLN AND JOHNSON

CHELSEA.

UNION REPUBLICAN TICKET.

For Presidential Electors.

At Large. { EDWARD EVERETT, of Boston. WHITING GRISWOLD, of Greenfield.

FOR GOVERNOR, JOHN A. ANDREW, of Boston.

FOR LIEUT.-GOVERNOR, JOEL HAYDEN, of Williamsburg.

For Secretary of the Commonwealth, OLIVER WARNER, of Northampton.

For Treasurer and Receiver-General, HENRY K. OLIVER, of Lawrence.

For Auditor, LEVI REED, of Abington.

For Attorney-General, CHESTER I. REED, of Taunton.

For Representative to Congress, 4th District, SAMUEL HOOPER, of Boston.

For Councillor, District No. 3, NEHEMIAH BOYNTON, of Chelsea.

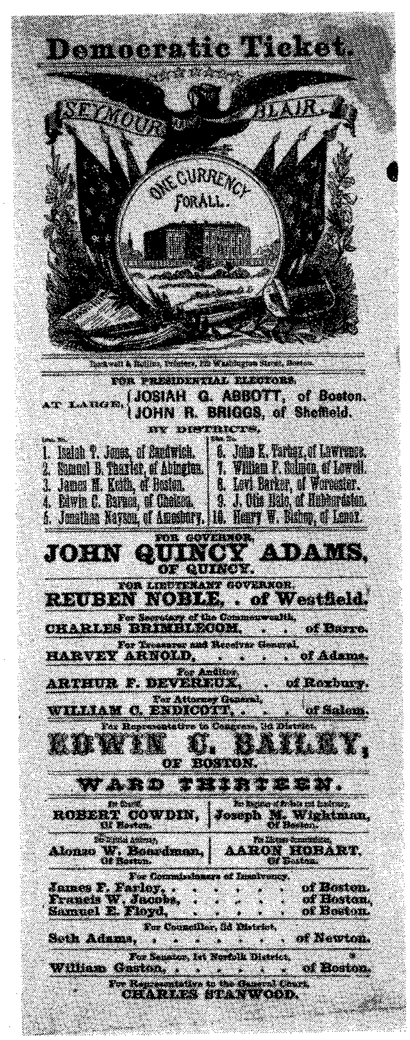
For Senator, District No. 1, HIRAM A. STEVENS, of Boston.

For Representatives, District No. 13, TRACY P. CHEEVER. | EDWARD H. ROGERS.

For Register of Deeds, JAMES RICE, of Boston.

For Commissioners of Insolvency, JAMES BAILEY RICHARDSON, HORACE H. COOLIDGE, of Boston.

For County Commissioner, Middlesex County, JOSEPH H. WAITT, of Malden.



Democratic Ticket.

SEYMOUR BLAIR.

FOR PRESIDENTIAL ELECTORS.

AT LARGE, { JOSIAH G. ABBOTT, of Boston. JOHN R. BRIGGS, of Sheffield.

BY DISTRICTS.

1. Isaiah T. Jones, of Sandwich.	6. John K. Tarbox, of Lawrence.
2. Samuel B. Thaxter, of Abington.	7. William P. Salmon, of Lowell.
3. James M. Keith, of Boston.	8. Levi Barker, of Worcester.
4. Edwin C. Barnes, of Chelsea.	9. J. Otis Hale, of Hubbardston.
5. Jonathan Nayson, of Amesbury.	10. Henry W. Bishop, of Lenox.

FOR GOVERNOR, JOHN QUINCY ADAMS, OF QUINCY.

FOR LIEUTENANT GOVERNOR, REUBEN NOBLE, of Westfield.

For Secretary of the Commonwealth, CHARLES BRIMBLECOM, of Barre.

For Treasurer and Receiver General, HARVEY ARNOLD, of Adams.

For Auditor, ARTHUR F. DEVEREUX, of Roxbury.

For Attorney General, WILLIAM C. ENDICOTT, of Salem.

For Representative to Congress, 3d District, EDWIN C. BAILEY, OF BOSTON.

WARD THIRTEEN.

ROBERT COWDIN, | Joseph M. Wightman.

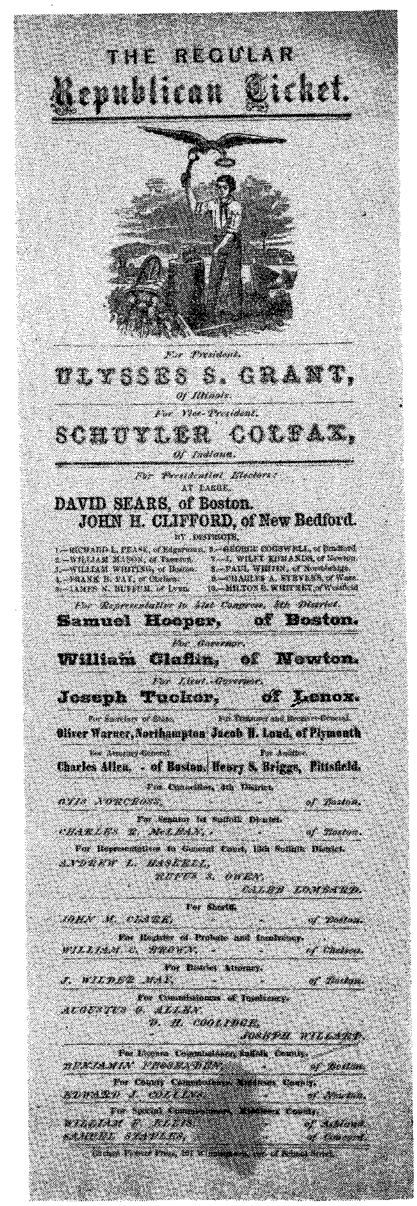
Alonzo W. Boardman, | AARON HOBART.

For Commissioners of Insolvency. James F. Farley, Francis W. Jacobs, Samuel E. Floyd, of Boston.

For Councillor, 3d District, Seth Adams, of Newton.

For Senator, 1st Norfolk District, William Gaston, of Boston.

CHARLES STANWOOD.



THE REGULAR Republican Ticket.

For President, ULYSSES S. GRANT, Of Illinois.

For Vice-President, SCHUYLER COLFAX, Of Indiana.

For Presidential Electors: AT LARGE. DAVID SEARS, of Boston. JOHN H. CLIFFORD, of New Bedford.

For Representative to 41st Congress, 4th District, Samuel Hooper, of Boston.

For Governor, William Claflin, of Newton.

For Lieut.-Governor, Joseph Tucker, of Lenox.

Oliver Warner, Northampton | Jacob H. Loud, of Plymouth

Charles Allen, of Boston | Henry S. Briggs, Pittsfield.

OTIS NORCROSS, of Boston.

CHARLES R. McLEAN, of Boston.

ANDREW L. HASKELL, RUFUS S. OWEN, CALEB LOMBARD.

JOHN M. CLARK, of Boston.

WILLIAM C. BROWN, of Chelsea.

J. WILDER MAY, of Boston.

AUGUSTUS G. ALLEN, D. H. COOLIDGE, JOSEPH WILLARD.

BENJAMIN PRESCOTT, of Boston.

EDWARD J. COLLINS, of Newton.

WILLIAM E. ELLIS, SAMUEL STAPLES.

1868

Both Republican and Democratic parties offered a full slate of candidates on the ballots for 1868. Horatio Seymour and Francis P. Blair, Jr., were defeated in the election by Ulysses S. Grant and Schuyler Colfax.

THE ROLE OF SCIENCE IN HUMAN WELFARE

By L. A. DuBRIDGE

THE TRAGEDY of the modern "scientific age" is that so many people do not know what science is.

If you turn to the so-called science section of a daily newspaper or weekly magazine, what kind of things do you read about? Jet airplanes, atomic bombs, radar, television, rockets to the moon.

Well, whatever science is, it is *not* these things. The relation between these things and science is somewhat like the relation between an automobile and the factory that produced it.

Radar, atomic bombs, and television are *products* of science. The automobile is the product of the factory, but we don't confuse the factory with the automobile. We call them by different names. What then *is* science?

Science is that great body of knowledge about nature which man has accumulated over the ages. With this knowledge man has found it possible to develop useful things—for his comfort or happiness, for peace or for war.

Similarly, the scientist is not the man who develops radar, the atomic bomb, or television sets; the scientist is a man who is seeking knowledge. He is trying to find out about nature, about the facts and principles which govern the physical world, including the men who live in the physical world.

Who is it then who takes this knowledge and uses it to make things? There is no single term to describe such men. I like to use the term "technologists" for them. The technologist is a person who uses the knowledge of science to develop or design or to bring into being things that men want at a particular time—whether it's a new industrial product, a weapon of war, or a new medical technique.

An engineer, for example, is one type of technologist. His job, in general, is not to discover new knowledge, but to take the knowledge which has been discovered in past ages and use it to design better structures, better bridges, better automobiles, better radio sets. An engineer has the additional job of putting a dollar sign on his work, because the things he designs must not only work, they must also be relatively cheap. Somebody has defined an engineer as a fellow who knows a thing will work before he builds it, because any fool can tell afterwards.

Now, it's quite easy to get scientists and technologists confused with each other, because the training they have is much the same, they are much the same sort of people, they have to have somewhat the same background of knowledge, and, as a matter of fact, one often converts himself into the other.

For example, when a war comes along, a lot of scientists leave their science, and turn their attention to military technology, and they may develop radar, atomic bombs, or penicillin.

Similarly, some technologists start searching for more background knowledge to help them in designing the things they're interested in, and they turn into scientists seeking new knowledge.

I think this contrast between science and technology is most important to keep in mind. Science and scientists have to do with the pursuit of knowledge, and usually with the pursuit of knowledge for its own sake. Their goal is the understanding, the comprehension of the physical world. The technologist has as his aim the meeting of some of the practical needs of men, by using the knowledge which the scientists have produced for him.

In general, it's a long road from scientific discovery to practical application. Many people seem to think that the scientific discovery of one day is the device you buy at the store on the day following. Well, it doesn't happen to be that simple.

It is a long, painful road from discovery to practical realization. Usually it is not a single road, but a road of trial and error; a road of backing and filling; of discoveries coming together, and being related to each other, and leading to new discoveries; of discovery leading to a new technology, and that technology reflecting back and aiding new discoveries.

One could go through the history of science and trace out case after case in which this long and difficult trail has been followed. There are some who think that the atomic bomb was something of a special case—that here a discovery was made one week and a bomb was ready the next. But even here the beginnings of nuclear physics date back at the very least to the time of Becquerel in the 1890's, and to the Curies and Rutherford in the early 1900's. For 40 years scientists worked

Excerpts from a speech delivered at the Pasadena City College Tuesday Evening Forum, September 30, 1952 in this field of nuclear physics, on the nature of the atom and the atomic nucleus—its size, its weight, its behavior, its energy—learning a great deal that would enable them to predict and understand nuclear experiments. The bomb could not have been made without all this accumulation of knowledge.

I remember how industrial companies used to chide us in the universities in the days before the war. "All the graduate students that you train come out well versed in nuclear physics," they said, "but nuclear physics is obviously a field that will never be of any use to anybody. We wish you would train these people in optics and mechanics and chemistry and a few things that have some industrial practicality."

Today, these same companies are covering the country with their recruiting teams, looking for more nuclear physicists. And today physicists are in search of knowledge in other fields. Soon, of course, the industries again will be complaining that physicists are impractical—but in another ten or twenty years the impractical experiments of the physicists of today will become the engineering necessity of the industry of tomorrow.

Why then is science valuable? First, because it is better to know than to be ignorant—because knowledge is desirable for its own sake. Secondly, because knowledge helps men attain things they want—cures for disease, machines to relieve them of the necessity of human slavery, houses to protect them better, better places in which to work, better agricultural techniques, and a thousand things which have advanced human welfare.

Is the end in sight? As I've already suggested, we've hardly begun this process of learning about nature, and using the facts that we've learned from nature to devise and develop things which we can use. We're still in a really primitive state in certain fields.

Consider, for example, the problem of food. In many parts of the world, human hunger is still a present danger, astonishing though it may seem. This is partly because modern agricultural techniques have not as yet been adopted in certain parts of the world; often their adoption is prevented by social, economic, political or even religious reasons. A vast educational program may be necessary before modern technology can solve the problems of hunger in over-populated portions of the world.

But, though many of the technical problems have largely been solved, agriculture is still a very primitive art—hardly even a science. It was developed through the centuries by trial and error—by observing what kinds of foods would grow in what climates, in what kinds of places. Only in recent years have men really begun to study plants as a scientific project, to understand the chemistry and physics of plant life, and to get a few hints of the nature of those complex processes through which soil, air, water, and sunshine all come together to produce usable and edible food.

In recent months, for example, at Caltech, workers have discovered for the first time the chemical reaction which accompanies the ripening of fruit. It is now quite possible that, by injecting a particular chemical into a partially ripened fruit, one might cause it suddenly to ripen. Or, one might delay the ripening by an inhibiting chemical.

Possibly, by further knowledge of chemistry, one can adapt fruits to climates where they do not now have a long enough growing season.

Only in recent years also have we come to understand the complex process which we call photosynthesis—the process by which solar energy is converted into chemical energy, the energy of food. It has been known for a long time that this was the essential process in plant life and plant growth, but the chemistry and physics of this photosynthetic process has just begun to be unravelled.

Someday, I suspect, as our supplies of coal and oil and other fuels get scarcer or more expensive, and as our demands for additional sources of energy increase, we may become more dependent on solar energy. The energy of the sun is almost unlimited. It is also something we can depend on—for the next few billion years, at least. If we could only find ways of converting it more efficiently into more useful forms, it would be an enormous boon to mankind.

Photosynthesis may be the key to this, because in this process solar energy is converted into chemical energy. We may be able to develop methods whereby this process takes place more efficiently and on a larger scale, so that we can use the products of photosynthesis for fuel as well as for food.

In any case, it's certain that in coming years our knowledge about plant life, plant physiology, and plant chemistry, will continue to grow; and, as a result, agricultural technology will make giant strides forward. There should be no reason, in a few years, why hunger should any longer exist on the face of the earth. If it does, it will be solely for social, religious, or political reasons, and not for technological ones.

Medical technology

There are many ways in which medical technology is still an art rather than a science. Only in the last 50 years has medical practice really been revolutionized by new discoveries in physics and chemistry and biology. The X-ray, which was discovered in a physics laboratory by a physicist who hadn't the slightest thought of making any contribution to medicine, has helped to revolutionize medical practice. Discoveries in chemistry and in other branches of physics have been equally important. Yet, today, we understand very little about the complex physical and chemical processes that really go on in living matter. Some of the simplest processes are the most mysterious to us.

For example, I suppose the simplest form of life—or what we can call life—is the virus. Viruses are, under certain conditions, just ordinary chemicals—complex organic chemicals. They can be crystallized, dissolved, filtered, and stored away, just like ordinary table salt.

Under proper conditions, these viruses suddenly acquire the property—which is characteristic of living things—of reproducing themselves. They can multiply with astonishing rapidity. They can multiply through many generations in a few minutes.

For example if a single virus of the proper kind attacks a bacterium (a bacterium being much larger than a virus), it will multiply so rapidly that within about 15 minutes that bacterium will literally explode.

This is a very nice property which some kinds of viruses have—that of destroying bacteria. Those particular viruses which destroy harmful bacteria are great friends of man. But there are other viruses which are not such good friends, because they, in their multiplication processes, cause diseases such as pneumonia, tuberculosis, polio, and the common cold.

We don't know how to conquer these viruses yet, or how to find something which will destroy them. But work is now proceeding. Only last spring a really new and revolutionary technique for studying the viruses was developed by a scientist at Caltech.

Monkeys were used in early virus studies. Dozens of them would be injected with viruses. Then would come weeks or months of waiting to see if they got sick, and, if so, what was the matter with them. It was a terribly expensive and time-consuming process.

Then somebody found that you could infect the embryos of chickens, and so, instead of cages of monkeys, you had cases of eggs. But even this was a slow and difficult process.

Now it's been found that ordinary animal tissue can be made to grow in a little dish, and the virus can be made to infect that tissue. Almost immediately, spots will arise where individual virus particles have attacked that tissue. So, within minutes or hours, one can do experiments which formerly took weeks or months.

Furthermore, these dishes can be stacked up by the thousands in a small laboratory and experiments can be done in parallel, under controlled conditions, at an enormously increased rate over what was possible just a year ago. This will accelerate the accumulation of our knowledge as to what these virus particles are, how they behave, what chemicals stimulate or retard their growth, cause them to die or to become inactive.

This is one of the most important problems in the field of medicine. And it will be solved by studies in chemistry and biology, in laboratories and universities where people are working, trying, for the sake of knowledge itself, to learn more about these mysterious particles—not only because they're dangerous and important to human beings, but because, by their very simplicity, they take us down to the basic elements of life and give us a little better inkling as to the nature of life itself.

What must be done if we are to make continued progress in the field of science, and if we are to use science to the maximum to advance human welfare? Well, I sometimes get worried because so many people still think that jet airplanes and atomic bombs are synonymous with science. When Congress appropriates money for government laboratories to develop better bombs, better airplanes, better weapons of war, or when industry spends money for developing better television sets, better automobiles, and better airplanes, people conclude that "science" is being handsomely supported.

This has nothing to do with the support of science. This is the support of technology—the activities which make use of the knowledge which science is supposed to discover, and apply it to things which are useful. But if there is no science going on, where will come the knowledge which the technologists will apply?

Funds for science

In this country, in spite of the fact that we're somewhat better off than 25 years ago, the exploration and the support of science for its own sake is not being adequately—certainly not generously— supported. It is extremely difficult to get adequate funds and even adequate people, because of salary competition, to carry on investigations in the field of science.

It is primarily in the universities that the search for knowledge has always flourished. And do universities find it easy to secure money for this scientific exploration? Well, you all know that the problem of financing universities is difficult. It is difficult both for state and private institutions.

We do not complain about the difficulties. It's all right to have to sell one's ideas and to have to seek money for them. But the thing that disturbs scientists is to be told that they are already too rich—that there are billions of dollars now being spent on science in this country.

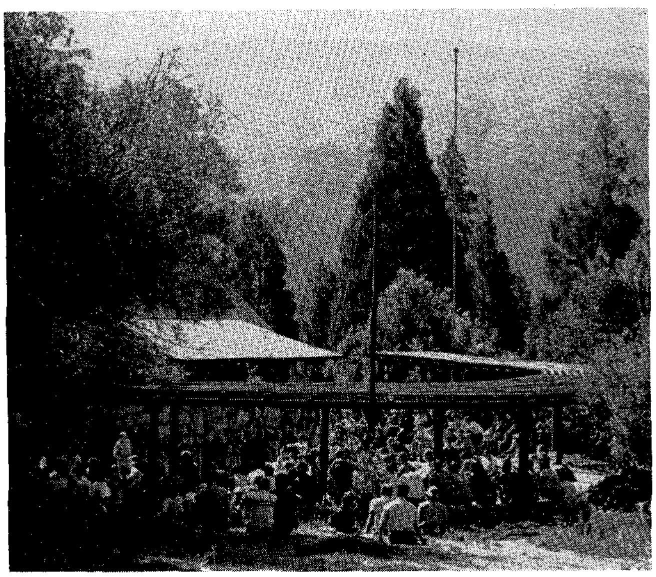
There are billions of dollars being spent on military and industrial technology. But the amount being spent on science can be measured in a small number of millions of dollars per year—a small percentage of the amount we're putting into technology.

And so I think that some of the lessons which we as laymen and citizens ought to learn, is that science and technology are handmaidens. Science comes first and lays the foundation. Technology builds upon it a superstructure which you see and which is useful. But without the solid foundation of science, the superstructure couldn't be built; or, if built, could not long last.

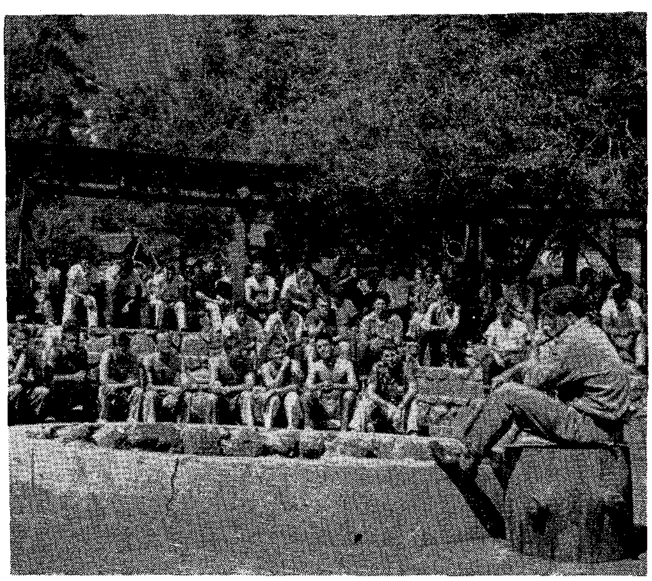
I think one could say that this scientific exploration, the search for knowledge, has proved over the generations to be useful for its own sake. It has yielded to man a satisfaction in replacing ignorance with knowledge, and has given him the practical results of being able to shield himself against the calamities of nature and the calamities imposed by other men. And this knowledge and this ability will expand and give rise to increased welfare of men in future years.

A FRESHMAN VIEW

The bus trip? Dull. Conversation? Nil.



Speeches begin immediately after lunch . . .



. . . followed by speeches . . . delayed by speeches

Friday, September 26, 1952

Off to camp at 8:30—only half an hour late. Understand this is pretty good timing for these things. . . . The bus trip is rather dull. Scenery? Certainly not the best in California. Conversation? Little or none—though somebody does start a lively, if somewhat one-sided, discussion of perpetual motion machines. This seems to be a standard, if meaningless, origin of conversation among future engineers and scientists.

The camp is quite a change from the quasi-desert areas around San Berdu. . . . We arrive just in time for lunch. . . Not bad either. . . Speeches begin immediately after lunch, with an unpredicted and unprecedented rain the only hitch in the program. Then more speeches . . . followed by speeches . . . delayed by speeches.

Everybody seems to be playing volleyball. One group is so lazy it plays a full game while sitting on the court. Claims the net is too low for a normal game.

Mountain golf has captured the hearts of many of the class, but there's always a faculty member around to cut any players down to size.

Ping-pong and singing are the most popular evening recreations. Those ping-pong games are really vicious. . . The way they hit those balls—if you can't hit 'em, you have to duck 'em.

Well, it's almost 10:30 and lights out.

Better finish this account of today's doings and not get caught when the lights go off. Understand the lights are on a time clock and go out at exactly 10:30. If they really go out on schedule, then—

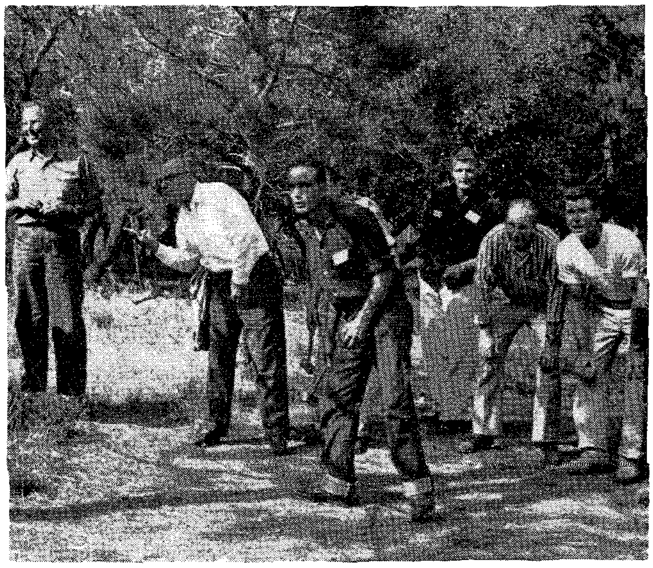
Saturday, September 27, 1952

They did.

Speeches, orations, tirades, circumlocution, loquacity, lectures, effusion, what-have you. . . We heard a lot of it today. Some of the speeches, when I think of it, were unforgettable—some, unforgivable.

Of course, I don't imagine I'll remember all of the

OF FRESHMAN CAMP



Mountain golf grips the faculty like a fever

speeches, and I doubt that I'm expected to; but I'll probably remember the essence of them until just plain experience teaches me the same things all over again. . . Then I'll probably be telling some poor, uninformed Freshman what my own personal secrets for getting ahead are.

Tonight was the Grand Amalgamated Concert. The folders described it as being "impromptu," but I've never seen so many guys—who would no doubt rather be out playing volleyball—work so hard as these band members did on a "spontaneous and extemporaneous" routine. . . Not only that; it was pretty good, too. . . The turnout for the band was amazing. They even had *two* sousaphone players. Only one sousaphone, though—thank Heaven . . . What a range of music. All the way from marches, through German Band music, to the William Tell Overture. . . Another highly lauded group was a decatet (or thereabouts) which sang such old favorites as "The Curse of an Aching Heart," "When You Wore a Tulip," and "Let Me Call You Sweetheart"—the first of which threatened (the verb is literal) to sweep onto the hit parade list.

Sunday, September 28, 1952

Today we came home.

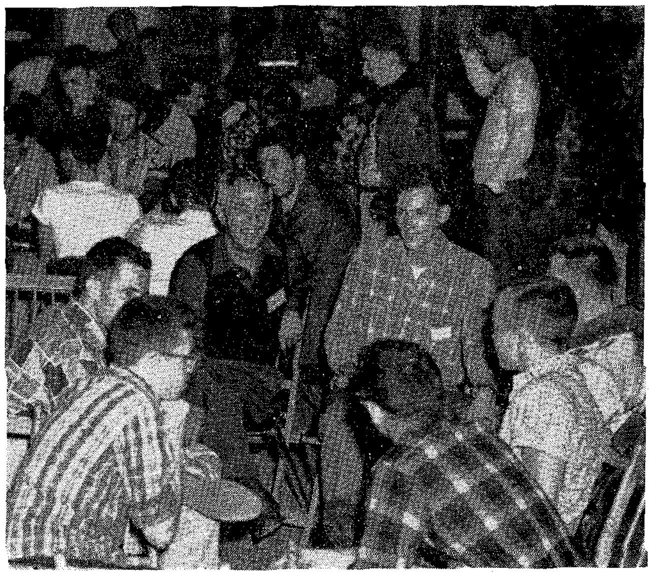
We woke up on Pacific Standard Time, and, even though the program stated that we would stay on Daylight Saving Time, the watches in camp differed by upwards of three hours at various times.

Then there was the Faculty-Frosh baseball game. I watched this until the bitter end, and it was pretty bitter—28-7 in favor of the faculty.

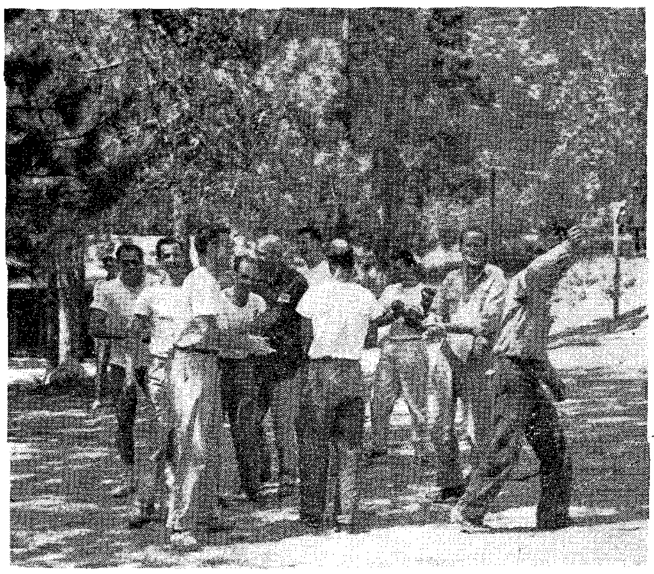
Back into the busses and back to school.

Somehow the bus ride didn't seem quite so sceneryless as before, and the conversation, which raged almost uncontrollably, was about less technical subjects: girls. Well, equally technical maybe—but less limited. . . Come to think of it, I don't know when I've enjoyed a bus trip more.

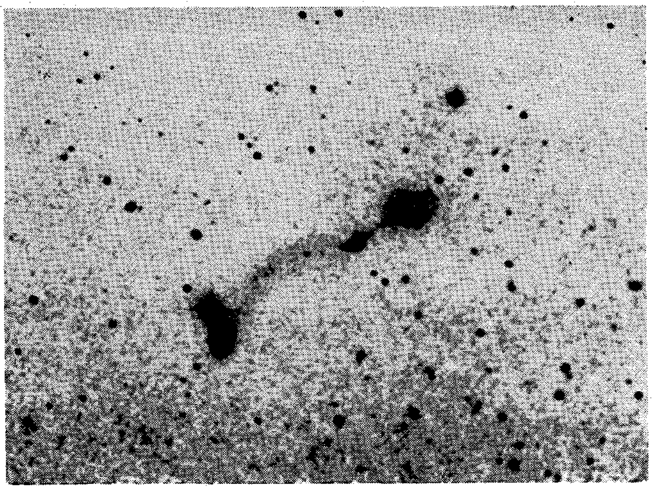
—*Bill Barlow '56*



President DuBridge joins a Freshman bull-session



The faculty baseball team celebrates a victory



This photograph from the 48-inch Schmidt telescope (enlarged 17 times) reveals how some extragalactic nebulae are connected. The three black objects in the center of the picture are galaxies like our Milky Way. A band of luminous matter runs between them like a lighted, gently curving boulevard.

BRIDGES IN SPACE

By ROBERT G. FIEDLER

Astronomical research at the Institute has shown that some widely-separated extragalactic nebulae do not necessarily live in complete isolation from each other. Luminous bridges more than ten thousand million million miles long—substantially longer than any previously known—have been found to extend between a number of these gigantic starry islands which float by the millions in the universal ocean of space.

These observations were made by Dr. Fritz Zwicky, Professor of Astrophysics, and have been confirmed with various instruments at Caltech's Palomar Observatory and the Mount Wilson Observatory of the Carnegie Institution of Washington.

When men first started asking questions of the stars, the universe they knew was relatively small. In the time of Galileo that universe embraced a few thousand naked-eye stars plus the planetary system—the sun and its attendants: Earth, Mars, Venus, Jupiter, etc.

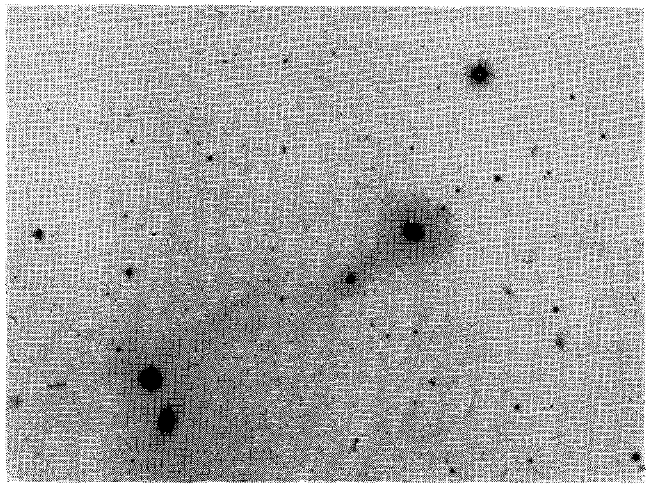
As man grew older and wiser, so did his insignificance as an occupant of the universal ocean grow—but so, too, did his vistas and the scope of possible new worlds to conquer. Life became more exciting for those men who liked to gaze at the stars and ponder the questions the stars themselves posed, when they realized that their planetary system was only a small part of that hazy, star-peppered streak in the sky which they knew as the Milky Way or the Galaxy.

And then, in our own generation, man's place in the universe shrank again as he devised more powerful instruments to probe the obscure depths, and put these instruments into the skilled hands of men with disciplined minds to do with as they willed. So, inevitably, man became more insignificant still in the large scheme of things, but now his eye and his mind could range over an almost incomprehensible sweep.

For Dr. Edwin P. Hubble of the Mount Wilson Observatory discovered that some of the fuzzy bright spots astronomers had been looking at were not the dust-and-gas clouds they had thought, but actually were composed of stars. This meant they were agglomerations like our own system, the Galaxy—bustling with the same sort of activity, inhabited at least by stars, and probably also by counterparts of objects residing in the Milky Way: dust, gas, star clusters, etc. He called them extragalactic nebulae* and found they were at distances which have come to be known as "astronomical."

*Some astronomers call these vast stellar systems "galaxies," since they resemble the system of the Milky Way. Others prefer to maintain the traditional definition of "Galaxy": the Milky Way; and to call the systems outside it "extragalactic nebulae." The latter, however, should not be confused with "nebulae" in the Milky Way, which are nebulosities or clouds of gas and dust. All nebulae discussed in this article are extragalactic.

This photograph from the 200-inch Hale telescope shows the same system pictured in the 48-inch plate across the page. The bridge joining the objects is still apparent, though this picture is enlarged only 3½ times. The internebular bridge, incidentally, is more than 72,000 light years long.



Astronomical research at Caltech reveals that a number of widely-separated extragalactic nebulae are actually connected by luminous bridges in the sky.

So remote are these nebulae that the mile becomes almost as minuscule as its inventor, and astronomers talk of their separation from us in terms of light years. One light year is roughly six million million miles, the distance light travels in one year at 186,000 miles each second.

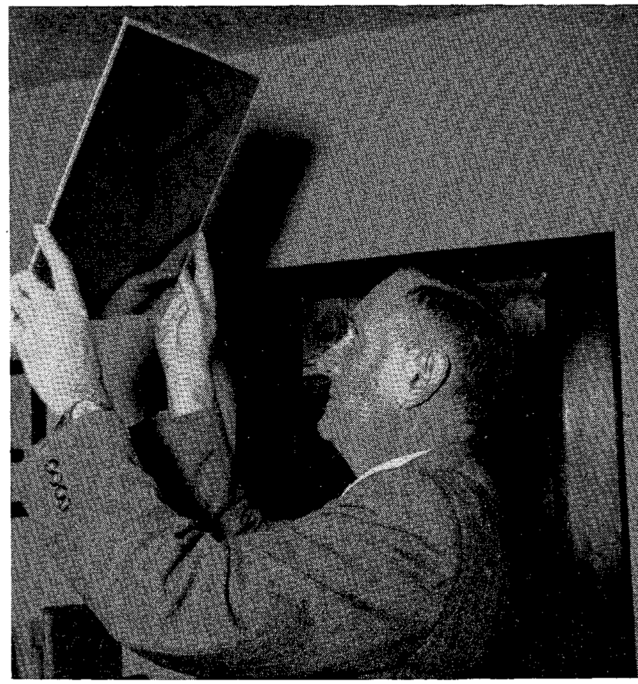
After the identification of extragalactic nebulae, astronomers found that luminous filaments sometimes join comparatively close double nebulae, like the bars of dumbbells. But it had not been generally known that faint luminous clouds stretching between nebulae separated by extremely great distances—many times the diameters of the nebulae involved—are relatively common. Professor Zwicky found such internebular highways in plates exposed with the 18-inch Schmidt telescope on Palomar Mountain and later with the 48-inch Schmidt, which—like the 200-inch Hale telescope—has proved capable of recording fainter objects than had hitherto been possible. The phenomenon is illustrated in the following example (one of the first encountered):

The system in question (see page 20) consists of three nebulae in the constellation of Virgo at a distance of about 50 million light years from the earth. Between the nebula (IC3481) at the upper right and the one (uncatalogued) immediately below and left of it lies a band of luminosity almost as sharply delineated as a lighted boulevard. Between the anonymous nebula and the one (IC3483) at lower left arches a somewhat less sharply defined strand shaped like an oriental sword. On the present distance scale IC3481 and IC3483 are separated by a projected distance of 72,000 light years. Thus the internebular cloud, because of its yataghan-like course, has a span greater than 72,000 light years.

The photograph from the 48-inch, largest of the Schmidt-type instruments, was enlarged 17 times from the original plate and its contrasts enormously enhanced by repeated alternate printing on contrast plates. On the original plate the contrast between the cloud and the sky background is so slight that a casual observer might easily miss it. Professor Zwicky notes, however, that once the observer knows what to look for, a discerning eye can readily detect many similar cases. The most important of the systems so far spotted are now being photographed with the 200-inch telescope.

What are the constituents of the lane between IC3481 and IC3483? Red- and blue-sensitive plates from the 48-inch Schmidt and the Mount Wilson 100-inch telescope seem to indicate that the cloud is relatively blue although many shades of color exist. This may mean that the material differs in composition from one region to another, and one possible explanation is that there are different relative numbers of blue and red stars in it. It has not yet, however, been resolved into stars.

It is possible only to make a guess as to how this



Dr. Fritz Zwicky, Professor of Astrophysics at Caltech, examines a plate from the 48-inch telescope to confirm his recent findings on internebular bridges.

lane came to be. One tentative explanation would run like this: The three nebulae may be rotating around, oscillating through, or passing each other. When they are at their closest approach they disrupt one another. They may then eject stars and perhaps other matter into the space around them. It may even be that some stars are escaping from the triple system entirely and hurtling into the space outside the cloud.

Another conceivable explanation might be that some of the internebular cloud, or perhaps even most of it, may have been formed when the nebulae were born or may have originated independently of them.

Whether such bridges are numerous enough to mean that the amount of matter in the universe has been underestimated by a significant amount is a question for the future. If they prevail widely, and if, in addition, dust is demonstrably present in internebular space (and Professor Zwicky believes he is accumulating evidence to this effect), then some revision may be indicated in such estimates and also in those portions of cosmological theories influenced by them.

The amount of matter in the universe, its distribution and the average density of the universe are all basic to cosmological theory. If one root factor changes appreciably, the effect is felt in all branches of the structure growing from it. Knowledge of the masses of the nebulae themselves is important to cosmologists, and one method of determining these masses is by calculation from appropriate measurements on *double* nebulae. However, it is not always irrevocably certain that two nebulae are true doubles when they are observable only in the line-of-sight. They might be several hundred thousand light years apart and the accuracy of the reckoning may suffer for this reason. But nebulae bridged by filaments such as Professor Zwicky has found are definitely double, triple or otherwise multiple systems with all their members at very nearly the same distance from the observer.

The discovery also has implications in the estimation of the distances of far-off objects. Astronomers cannot rule off or step off the distance to nebulae, and have had to resort to a roundabout method. This method depends on the absolute brightness of the object whose light they capture on photographic plates or in electronic instruments. Light, passing through a fog, is fainter on the other side of the pall than if it traveled through a vacuum. Thus, if dense internebular clouds should abound in space they might absorb enough of the light from distant nebulae to produce errors in the estimation of nebular distances.

One interesting sidelight is a possibility that the Milky Way itself may be joined to our 90,000-light-years-distant neighbor, the Nubecula Major or Large Magellanic Cloud. More than a century ago the British astronomer, Sir John F. W. Herschel, wondered about this as, "entirely without telescopic aid, when seated at a table in the open air, in the absence of the moon," he scanned the southern skies from a South African observatory at the Cape of Good Hope. He wrote that no branch of the Milky Way whatsoever forms "any certain and conspicuous junction with (the Nubecula Major); though on very clear nights I have sometimes fancied a feeble extension of the nearer portion of the Milky Way in Argo (where it is not above 15° or 20° distinct) in the direction of the nubecula."

Professor Zwicky has called this observation, and his own findings on internebular bridges, to the attention of the Commonwealth Observatory at Mount Stromlo, Australia. Astronomers there have replied that they will be on the lookout for any connection with the Large Magellanic Cloud, which is visible only in the southern hemisphere.

THE DIAMAT AND MODERN SCIENCE

Soviet scientists today must serve two harsh and exacting masters: the official credo of dialectical materialism, and the philosophy of science. How do they do it?

By PAUL S. EPSTEIN

IN STUDYING the position of intellectuals in sovietized countries the situation of scientists must be analyzed separately from that of writers and artists. Indeed, the conditions under which the scientists do their work are materially different from those which apply to other creative workers, and these differences derive from two sources.

In the first place, science, in general—and modern physics, in particular—has developed its own philosophical point of view. Therefore, the scientist finds himself obliged to serve two harsh and exacting masters: the official credo of dialectic materialism, on the one hand, and the philosophy of science, on the other. Thus arises the question to what extent the demands of these two masters are compatible.

In the second place, for the sovietized states, the usefulness of the results of scientific work is not of the same nature as the value of literary and artistic productions. This fact cannot fail to have some influence on the psychic atmospheres in which the two kinds of intellectuals live.

The term *diamat* is an abbreviation for *dialectic materialism,* current among Russian writers. We shall use this word to designate the particular form of dialectic materialism developed by Soviet philosophers, officially adopted by the Soviet government, and taught in the Soviet schools.

The purpose of the following pages is to discuss the conditions which the diamat—so understood—creates for scientists and for scientific pursuits.

1. DIALECTICAL MATERIALISM

It often has been said that Marxism is the religion of the Soviets; and by the same token the diamat represents the articles of faith of this religion.

Permit me to recall here a very profound remark made by Wilhelm Wundt. Only those articles of faith are well chosen which are beyond human reason; if they cannot be understood, they are safe from getting in conflict with the advances of knowledge and from being disproved by science.

Judged by this criterion, the diamat almost qualifies: it is true that it contains one embarrassingly positive point (to be discussed in section 5 below), which stems from the materialistic world view embodied in it. This is offset, however, by two other points, inherent in the dialectic method, which make it very flexible and almost take it out of the realm of logic:

(1) The diamat holds that *internal contradictions are inherent in all things and phenomena of nature,* or in Lenin's words: "In its proper meaning, dialectics is the study of contradictions *within the very essence of things.*"

(2) All reality is in constant flux and change, including the workings of the human mind. Knowledge is relative and truth unattainable: what is considered a good approximation to truth today may be found not so good tomorrow.

It would seem that a credo of such vagueness and adaptability should have made its confessors humble and prevented them from commitments on questions of scientific import. This was by no means the case. Beginning with Lenin, the theoreticians of the diamat made a number of pronouncements about questions of science which were quite unnecessary, in the sense that they were not inevitable consequences of the fundamental principles of dialectics. Nevertheless, these pronouncements became part and parcel of the official diamat policies and created a good deal of friction in the pursuit of science, resulting in disciplinary actions against individual scientists and in the condemnation of whole branches of scientific theory.

The action of the Soviet authorities against Mendelian genetics, which culminated in its complete annihilation, is too widely known to need more than mentioning. We shall restrict ourselves here to studying the conflicts of the diamat with the *science of physics.* This will give us a good picture of dialectics as it actually is, as it is interpreted in everyday practice by its official custodians.

2. PHYSICS AND THE DIAMAT

The task of enumerating the planes of friction between the diamat and physics is greatly facilitated by several Russian papers published during the last three years. One of them is a report under the title "Lenin and Natural Science" read in January 1949 before the USSR Academy of Sciences by its corresponding member A. A. Maximov.

It is obvious that, in a solemn session of the Academy, an author would not be permitted to express his private views if their general trend were not approved by the authorities: *it is the official party line that is* announced through the mouth of Mr. Maximov. The contents of his report make it clear that the authorities had become aware of the difficulties inherent in some mistaken assertions made by the representatives of the diamat, since the whole paper may be termed *an orderly retreat from untenable positions.*

Maximov employs the usual technique of the Soviet debaters: imputing to their adversaries the very sins of which they are guilty themselves. He sets up straw men in the persons of some mythical bourgeois scientists whom he charges with the mistakes, in reality made by the expounders of the official Soviet line; but he has the grace to admit that a few Russian men of science fell into the trap of uncritically accepting the corrupt bourgeois views. Then he goes on to define the correct materialistic vantage point.

The subjects taken up are: (1) the theory of relativity; (2) the alleged unreality of mathematical physics; (3) the apparent paradoxes of the quantum theory.

Although Maximov seems to know a good deal of science, his equipment is inadequate for a full understanding of theoretical physics. Hence, the job he did was superficial and incomplete, leaving the matter in a state where further strategic retreats of Soviet philosophy are unavoidable.

As far as relativity is concerned, a further step was indeed taken in 1951, in a paper by G. I. Naan which will be considered in the next section. It goes without saying that in the further discussion we shall present the older Soviet point of view, not as Maximov sees it, but as it stands revealed in the writings of Lenin and in other official sources.

3. THE THEORY OF RELATIVITY

In the field of the *theory of relativity* the Soviet philosophers created for themselves two difficulties, both of an entirely verbal nature. The first is inherent in the vagueness of the words "matter" and "material". These terms are remnants of eighteenth century ideas and do not form part of the formulation of any law of modern science. If used at all in scientific writings, they are catch-alls for ill-defined and varying qualities of nature.

Lenin was not satisfied with the vague definitions given by Marx and Engels but had recourse to the idea of identifying matter with mass; "Matter is that which has mass." In consequence, the observation of physicists, that the mass of an electron decreases as it slows down, troubled Lenin, since it seemed to involve the disappearance of matter, a conception which he was not prepared to admit.

The argument was later taken up by Lunacharski from the point of view of Einstein's law of equivalence of mass and energy. He charged that the bourgeois physicists were trying to remove from science the concepts of mass and matter and to replace them by energy. Hence, the theory of relativity is idealistic and must be condemned as contrary to materialism. Maximov correctly points out that there is actually conservation of mass, because the mass lost by the electron turns up as mass of the radiation emitted in the process of slowing down, so that the Soviet idea of materialism is not threatened by this phenomenon.

The second difficulty also derives from a verbal misunderstanding. It has its root in the rather unfortunate name chosen by Einstein, namely, *theory of relativity.* This leads to all sorts of misapprehensions since it seems to imply that there is nothing absolute. The Soviet theoreticians lay great stress on the absolute (if unattainable) truth and on the immutable laws of dialectics. Hence, the denial of all absolute values, which was imputed to relativity, was a stumbling block for the Marxist philosophers and a serious contributing cause of its condemnation.

In reality, the theory of relativity makes no such claims, and its importance does not lie in pointing out the variable aspects of most phenomena in dependence on the frame of reference: indeed, this variability was obvious long before Einstein.

The great achievement of the theory lay in the diametrically opposite direction, in the disclosure of the immutable invariants of nature lying behind its relative aspects.

As early as 1908 this was pointed out by Minkowski, who proposed to discard the name "theory of relativity" and to replace it by the term "theory of the absolute space-time." Maximov's background is insufficient to understand that the difficulty is self-created and imaginary; he believes in its existence and proposes several makeshifts to get around it. Quite unnecessarily, he suggests that the mathematical formulas of the theory of relativity must be accepted, but no philosophical conclusions should be drawn from them.

The most recent Soviet point of view is contained in the 1951 paper by G. I. Naan already mentioned: "On the Question of the Principle of Relativity in

CONTINUED ON PAGE 26

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Physics." With the most impudent perversion of truth, Naan makes a complete about-face and falsely claims that the bourgeois scientists of the West regard the theory of relativity as conflicting with materialism and, "acting with their usual rascally tricks," advance it as an argument against Marxism, while in reality there is no conflict. Section 4 of the paper is entitled "On the errors of A. A. Maximov and of others" and takes that author to task for not going far enough and not accepting the whole of relativity in its mathematical and philosophical aspects.

Thus a campaign of thirty years' duration against the theory of relativity—which had caused numerous scientists much inconvenience, and a few, serious mental and physical suffering—turned out to have been much ado about nothing.

4. IDEALISTIC USES OF MATHEMATICS

The problem of the so-called "idealistic uses of mathematics" by physicists also goes back to Lenin. As in the case of the notion of matter, the root of the difficulty lies in the persistence of some ancient ideas, long discarded by modern science. As seen by the early physicists, the aim of theoretical analysis consisted in the "explanation" of all natural phenomena in terms of movements and collisions of particles. However, this point of view broke down with the discovery of the properties of the electromagnetic field in the nineteenth century. Since the attempts to press them into the old mold were unsuccessful, it was proposed by Heinrich Hertz to take the equations given by Maxwell as the ultimate description of the electromagnetic phenomena, instead of trying to reduce them to mechanisms.

This approach (later extended to other fields of modern exact science) was troubling to Lenin. Inasmuch as these equations were set up by man, he argued, the electromagnetic field itself becomes a creation of the human mind and not a reality of nature. The theory is, therefore, idealistic and contrary to the materialistic world view. This is the original example of the so-called *idealistic uses of mathematics*, since then they were discovered by the priests of the diamat in the writings of many scientists.

With respect to this problem, Maximov's mediating position is correct and adequate. As he points out, the equations in question were derived from numerous observations; therefore, they represent the results of objective experiments fully as much as do the laws of mechanics.

Undoubtedly, Maximov's views had the endorsement, at least, of a part of the diamat authorities, but this does not mean that the subject of unrealistic theories was disposed of once and for all. It means only that the abundant use of high powered mathematics may be justifiable *in some instances* and that every case must be decided on its own merits. Thus the Soviet scientists are always at the mercy of the interpreters of the diamat.

More than a year after the reading of Maximov's report, serious charges were preferred against some of the leading organic chemists of Russia (1950). The accusations came from a committee especially set up by the USSR Academy of Sciences for the purpose of purging Soviet chemistry of all reactionary ideas borrowed from bourgeois science. Conspicuous among the charges was the idealistic use of mathematics.

5. THE QUANTUM THEORY

The areas of collision treated in the two preceding sections were due either to misconceptions or to arbitrary interpretations of dialectics. The only genuine conflict between science and Marxism exists in the field of the quantum theory. It is the more important because it is concerned with the only unequivocal assertion of Lenin's materialism incorporated into the official diamat.

In its ontological aspect the philosophy of Lenin is a primitive dualism: Complete reality is attributed to the *outer* (material) *world*, which is quite independent of its observers and would exist in the same form in their absence. In this respect, the saying of Engels is accepted: "The materialist world outlook is simply the conception of nature as it is, without any reservations." The second world, the *inner world* of the observer consisting of his sensations and perceptions, is produced by the stimuli of the outer world and constitutes its "reflection," that is, an approximate reproduction, which is at best close, but never ideally exact.

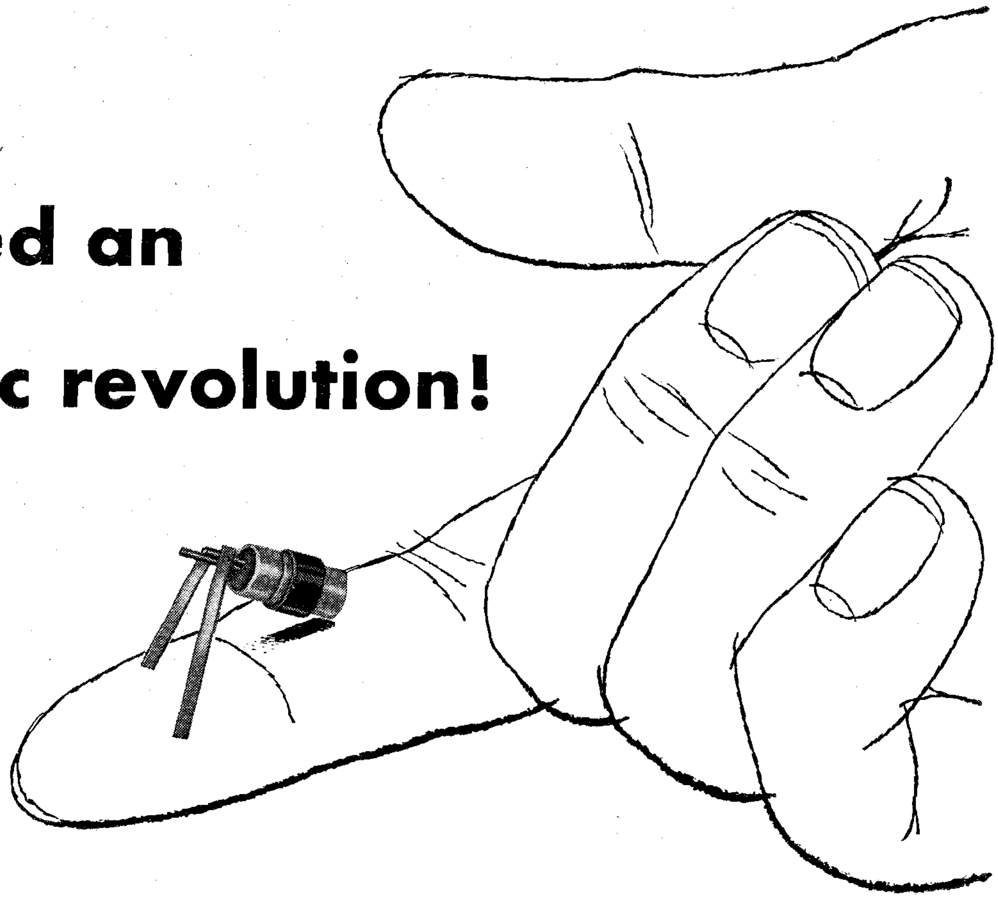
It should be pointed out that taking for granted that the things of the outer world always exist in the same form in which they are observed, is a metaphysical assumption, in the sense that Lenin had no objective way of knowing whether it was true and, certainly, no scientific foundation for it.

Since Lenin's time modern science—through its advances in the field of the quantum theory—has developed a world picture in some respects different from his, which may be termed a *modified dualism*. Of course, the physicist has to start from what is directly accessible to him, namely, from the *world of the observer*. He thinks of it, not in terms of sensations and perceptions, but as the physical world of the totality of his observations, secured by his measuring and recording instruments. The mathematical formalism developed for the best description of the accumulated data, however, contains the recognition of an *outer world* beyond the observer.

One part of this formalism consists in the mathematical means of describing the inferred outer world as long as it is unobserved; another part—of a different

CONTINUED ON PAGE 30

It sparked an electronic revolution!



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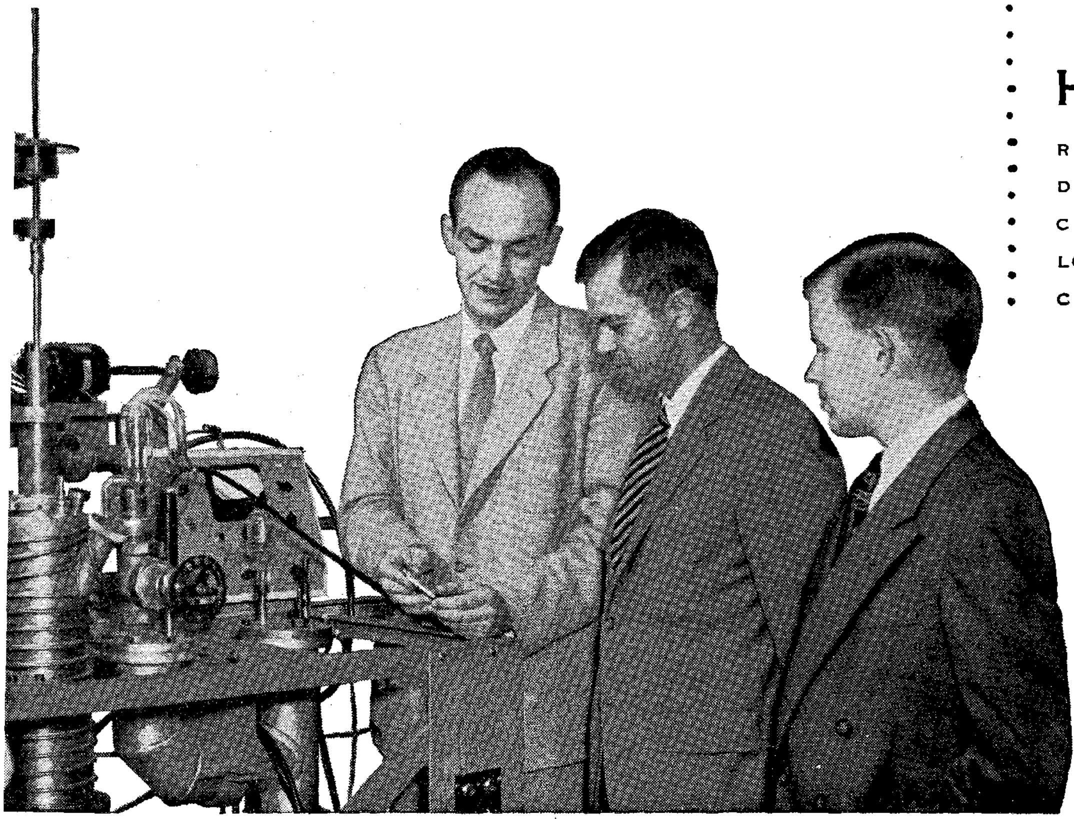

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mathematical structure—refers to the erratic disturbances which arise in the world of the observer through his unavoidable interference with nature, in the pursuit of his business of securing measurements.

This interference involves the well known interruptions of causality characteristic of the quantum theory, the so-called paradoxes of the principle of indeterminacy, which take place at the points of interaction between the outer world and the instrumental paraphernalia of the observer. We call this dualism *modified* because it is unlike the primitive realism of the diamat: the world of the observer is not a replica, or "reflection," of the unobserved outer world but is different from it because of the modifications introduced by the process of measurement. Indeed, the descriptions of the unobserved outer world is *causal* and that of the world of the observer *acausal*.

This is only one of the possible ways of bringing out the conflict between the point of view of modern science and primitive dualism; there are many other ways of stating it. It is true that the contradictions manifest themselves only in the narrow area of atomic and subatomic phenomena; but they are of a profound philosophical importance and have acquired practical significance since the utilization of atomic energy became a reality.

The position taken by the Soviet authorities in this conflict is reminiscent of the controversy between Galileo and the Vatican. The Roman Curia was ready to grant him the *imprimatur* on condition that he treated the revolutions of the earth as an astronomical theory and not as a fact. Similarly, the Soviet state permits the use of the quantum theory—including the principle of indeterminacy—as an instrument of scientific research in technical publications, but militates against its philosophical consequences.

It must be pointed out that the fear of the diamat philosophers to recognize the interaction of observer and observed is based on a misconception. What they are afraid of is the idea that the phenomena of nature are, in part, created or influenced by the human mind. This would be, in fact, *idealism;* and according to Lenin, "philosophical idealism is a road to clerical obscurantism" and, further, "religion is the opiate of the people."

But the world picture of the quantum theory is not, in any sense, idealistic; both the outer world and the world of the observer are physical worlds, and the reactions on the outer world which the theory postulates are caused by the *instruments* of the observer and not by his way of thinking.

It is easy to understand that the Russian authorities are reluctant to change the slightest letter of their creed, but it should not be hard to find a formula preserving its spirit and making the necessary concessions to science. In the long run this adjustment will have to be made, and it will be far more painful than the small strategic retreats announced by Maximov and Naan.

In the meantime, the Russian censors do not yet understand the situation; they see the ghost of idealism in quite innocent passages.

6. GOLDEN AGE OF SOVIET SCIENTISTS

In returning to the question of the situation of scientists in the Soviet countries, it is best to use the historical approach. Right after the communistic state was established and the diamat was proclaimed as its official credo, science became a very attractive field for able and ambitious young Russians, since it was the only type of intellectual activity unaffected by politics.

Writers and artists were expected to put their talents at the service of the state, and to engage in direct or indirect propaganda for the communistic way of life. On the contrary, science was indispensable for the Soviets' industrial future on its own merits, and the scientists played a role useful to the state in their legitimate pursuits as researchers and teachers. Compared with other Soviet citizens, their lot was indeed a happy one: they enjoyed a high social and economic standing and—apart from a few exceptional cases—they were unhampered by political interference in their work.

This accounts for the growth of the achievement and prestige of Russian science in the period between 1920 and 1936, which may be considered the Golden Age of the Soviet scientists. As private citizens they could accept the diamat or treat it with skepticism but, on the whole, they were free of conscientious scruples in their profession because the scientific philosophy, described in the preceding section, had not yet crystallized.

Even in this period the sky was not altogether cloudless. The authorities were pressing for practical results and were, at first, reluctant to support pure science; but at length they were persuaded that applications are contingent upon thorough basic research. A few philosophically inclined members of the Soviet hierarchy made nuisances of themselves by stirring up in their writings the spurious issue of idealism in physics, discussed in sections 3 and 4.

I am aware of several disciplinary actions against individual scientists on that score which should not be passed over lightly. The totalitarian state is so powerful and implacable that even those accused, who are ultimately exonerated, go through a period of acute mental anguish at the possible prospect of losing career and livelihood and ending up in a concentration camp. Yet, for two reasons, it seems unnecessary to enumerate these cases.

In the first place, they were not part of a concerted campaign of regimentation but the sporadic actions of individual high bureaucrats—either sincere but unwise zealots or jealous troublemakers.

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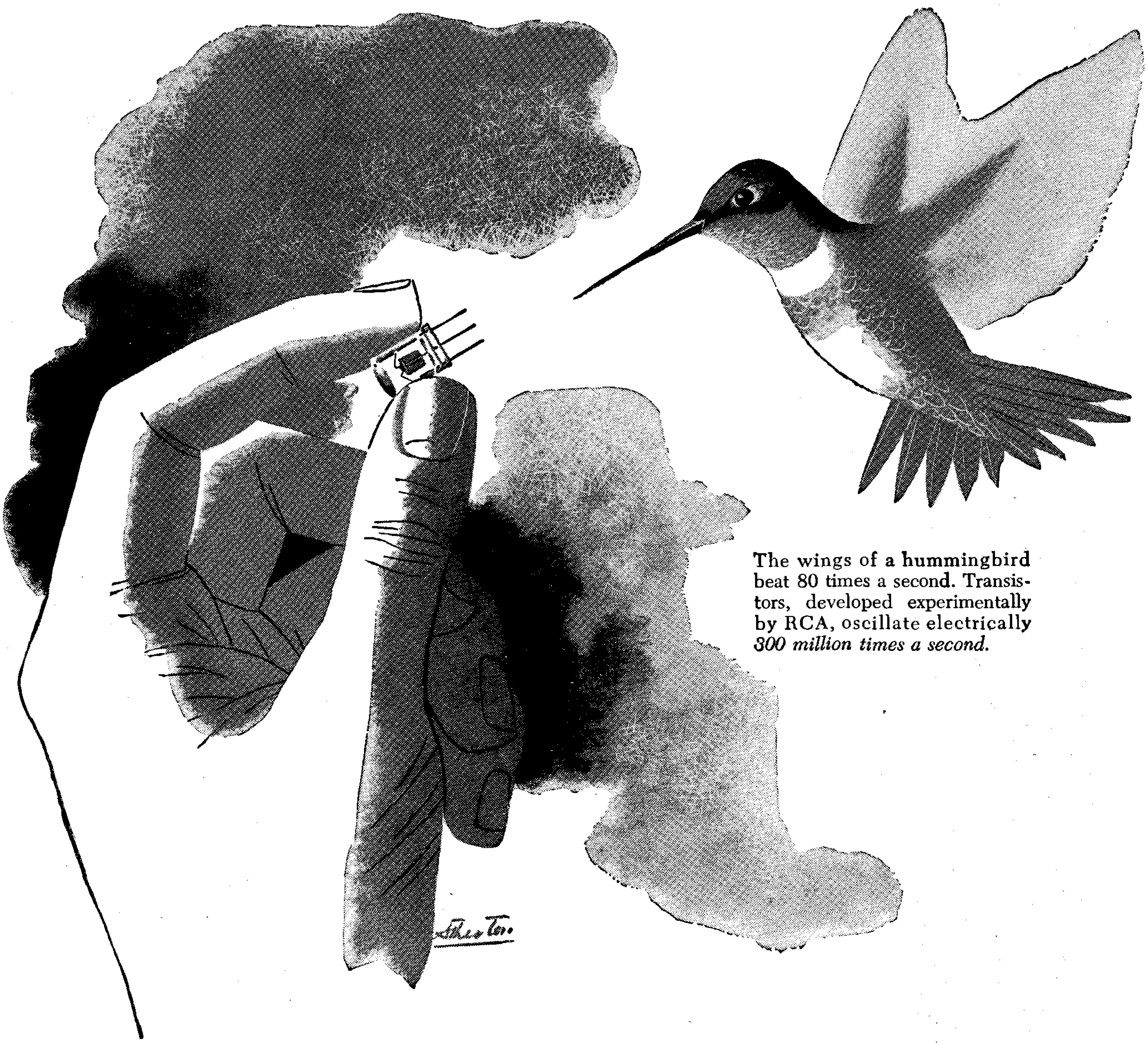

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In the second place, the grounds for the accusations lay usually in activities outside the laboratory, such as philosophically colored popular writings and oral utterances.

For the larger part of the period in question this was true even for the field of Mendelian genetics, whose results ran afoul of a particularly deep-seated complex of proletarian inferiority feelings. Although Mendelism had been early attacked by a few Soviet writers, the work of its exponents proceeded without interference until 1932. Sporadic actions against individual geneticists started only after that date, and a large scale persecution, including the dissolutions of the Medico-Genetical Institute, followed in 1936.

Soviet scientists today

I skip over the periods of the great purge and of the world war, as an abnormal and uncharacteristic time, and I turn directly to the present post-war era. In describing the situation of the scientific intellectuals I have in mind the USSR only. If the conditions in the satellite countries are different, this is probably due to a time lag: before long they will be brought in conformity with those in Russia.

The social and economic standing of scientists remains high and is not now appreciably different from that of the preceding period; but the mental climate in which they work underwent a considerable change due to their coming to grips with the diamat. While their former relations with dialectics may be described as a distant bowing acquaintance, two circumstances are now intruding it upon the intimacy of their professional lives.

In the first place, science is now in possession of its own epistemology, and the scientists are no longer philosophically innocent and neutral. The consequences of the quantum phenomena were fully developed and appreciated during the 1930's. Now even the rank and file understands them to be much subtler than is envisaged in Lenin's naive dualism.

In the second place, the government embarked on an ill-advised policy of rigidly enforcing the Marxist line, in science as well as in all other cultural activities. By a resolution of the Central Committee of the Communist party (1949) the scientists themselves were mobilized for the police work: every branch of science was directed to organize a committee "for the struggle against reactionary ideas of bourgeois origin."

A penetrating analysis of the relations of writers and artists to the diamat was given by Czeslaw Milosz in a 1951 book, *Situation of the Intellectual in the Popular Democracies.* Milosz divides them into two groups: those who serve Marxism without believing in it, succumbing to the inescapable necessities of their existence, and those who become sincere converts in order to achieve true self-expression by patching up the rift between their writings and their convictions.

The second way—the way of being true to their own selves by adjusting their beliefs to the party line—is closed to the scientists. They cannot accept the diamat epistemology, nor do they have a high opinion of dialectics as a research method. Hegel, Engels and Lenin claimed that it is only necessary to study "the contradictions within the very essence of things," in order to arrive at the truth about them.

The scientist will admit that in the rare cases when two independent scientific results seem to stand in sharp contradiction, the resolution of this contradiction always involves an important advance of science. However, the most thorough knowledge of the diamat does not equip the researcher for effecting the resolution. Finding it is always a difficult step, depending on the emergence of new scientific points of view, which often take a very long time to crystallize.

Indeed, one of the favorite examples, adduced by Soviet writers as illustrating the applications of dialectics to science, sounds almost like a derision of its methodological value. It refers to the inconsistencies in the axiomatic foundations of geometry which led to the discovery of its non-Euclidean branch. These difficulties were felt in antiquity, but they were not resolved until more than two thousand years later, through the new points of view supplied by Bolyai and Lobatchewsky.

The way of duplicity

The only adjustment left open to the scientists is the way of duplicity: giving lip service to the diamat and keeping silent about their reservations. Whatever the subject, all their writings, meant for a wider audience, follow the same formula: quotations from Stalin and Lenin in the introduction and conclusion, and a sneering denunciation of the corrupt western scientific practices at a convenient place in the middle. We have seen that the field of genuine conflict between science and dialectics is fairly narrow, being restricted to the quantum theory, i. e. to molecular, atomic and subatomic phenomena; therefore, one might have thought that most of the specialized subjects lie outside it. But arbitrary and spurious interpretations of both the diamat and science widen the danger zone to such an extent that it is almost universal. Especially, since policing committees were set up within the scientific organizations themselves, the most technical passages of the most advanced investigations are not immune from the accusation of containing "non-Marxian ideology."

The critical activities of the various committees, created by order of the Communist Party, have resulted so far in a report, rendered by the committee on organic chemistry, and an editorial in the journal *Kultura i Zhisn*, dealing with geography. These criticisms brand

CONTINUED ON PAGE 34

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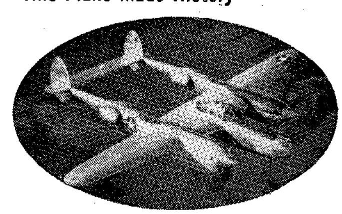

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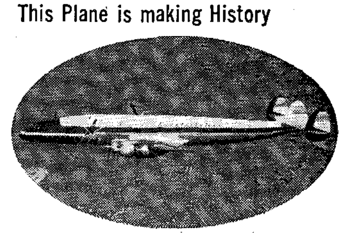

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as "ideologically faulty and reactionary" certain trends and theoretical conceptions of current research and list by name the specialists guilty of their uses—among them, some men of the first rank.

In particular, the accusations against the organic chemists are those of "idealistic uses of theory" and of "subverting the clear materialistic concepts, due to Russian scientists, by the faulty ideas of decaying capitalistic science."

In this year's public annual session of the USSR Academy of Sciences the accused scientists were put on the carpet for the purpose of "criticism and self-criticism." As in a revival meeting, they were expected publicly to confess their sins, smiting their breasts and repeating: "Mea culpa, mea culpa." According to the report in *Pravda*, not all of them submitted to the ordeal with the required docility, so that their cases are not yet closed.

How was the audience affected by this spectacle—by the sight of eminent men being forced to humiliate themselves, after a lifetime of devoted and successful service to science? Were the onlooking scientists captivated in favor of the diamat? Could they see in its champions anything but foolish doctrinaires or malicious intriguers? Indeed, the accusations were so arbitrary and unreasonable that only men completely unfamiliar with the mathematical methods of science could have advanced them in good faith.

A disturbing warning

It was a disturbing warning to all listeners: from now on they must watch carefully every word and expression they write, or they may find themselves in the same predicament. Inevitably, the worry and apprehension must make the process of publication distasteful to them, and must react back on their will to work. Their enthusiasm for research will be dampened if bringing out its results is connected with so much trouble.

It is true that most Russian scientists would find it difficult to reduce the quantity of their output. To a large extent, modern science has become a cooperative undertaking of many men, so that the planning of a research program of a national scale is very helpful in coordinating the work and eliminating duplication and waste of effort.

For a long time, national planning has been in the hands of the council of the USSR Academy of Sciences, which assigned definite research responsibilities to individual laboratories and scientists. It seems, however, that the government is now treating these assignments on the same footing as the quota assignments to industrial plants. In this year's meeting of the Academy many laboratory directors were publicly reprimanded for not fulfilling their quotas.

Apparently, the standing of a scientist is judged by the number of papers he publishes. The danger of this policy lies in the obvious fact that the authorities can prescribe the number and length of the publications but cannot control their quality. If the quantity of output must be maintained, the general flagging of scientific enthusiasm will, necessarily, lead to a lowering of research standards. It seems that this process is already well under way: during the last year several of my friends remarked to me on the deteriorating quality of Russian papers in the field of physics.

Even greater hazards await those scientists who tackle the difficult but necessary task of making the results of modern science accessible to a wider public. They are not allowed to use the expedient of the researcher—to present the underlying theories as mathematical devices and to refrain from discussing their possible bearing on philosophy. Instead, they are willy-nilly dragged into philosophical controversy.

A case in point is the recent book on *The Basic Conceptions of Modern Physics* by the academician A. F. Ioffe, the venerable builder of Russian physical research, the teacher of most men now prominent in his field. The review of this book in the official *Voprosy Filosofii* was written by a certain Omelianovsky who sermonizes the illustrious author like a schoolboy, reproaching him for keeping aloof from philosophy:

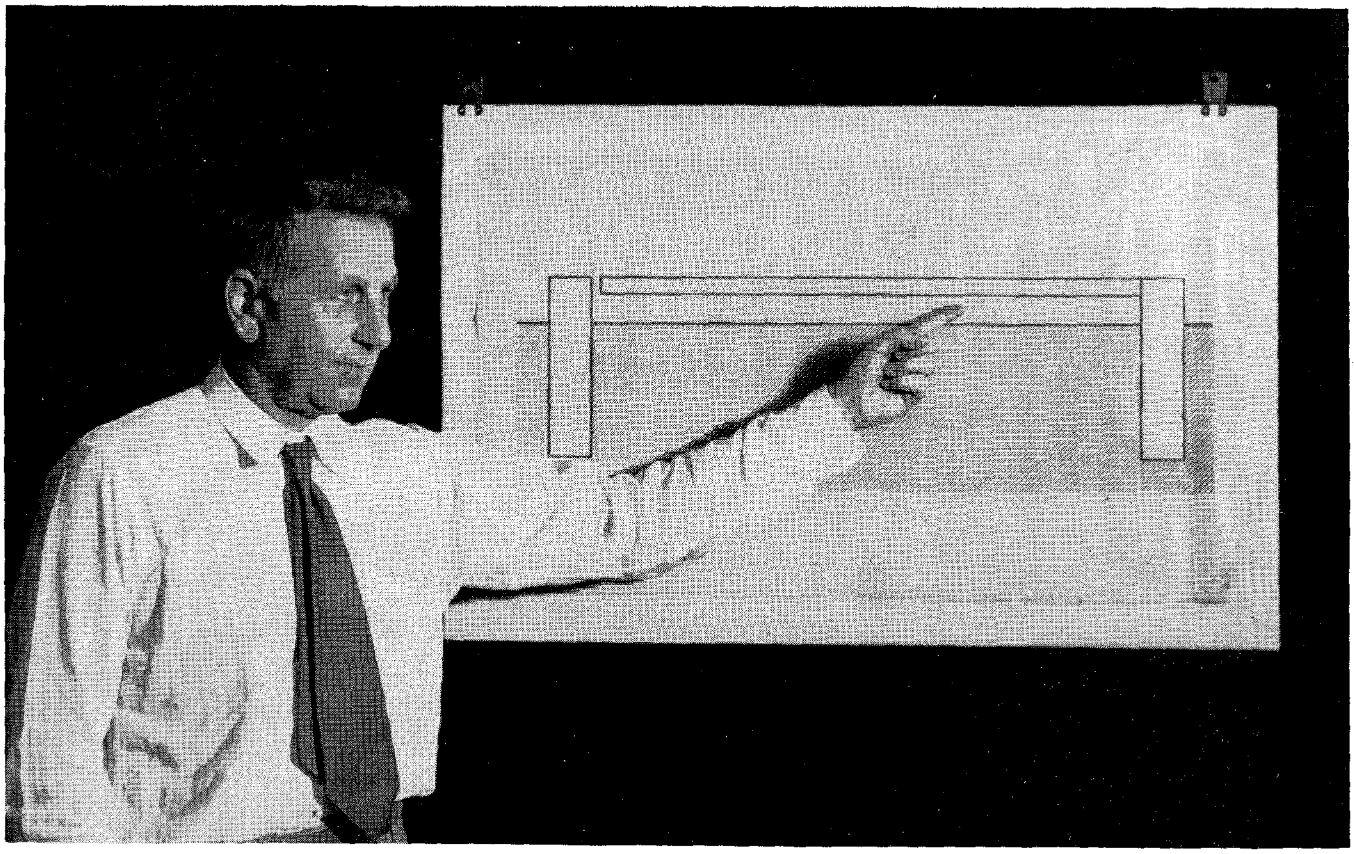
"A Marxist book . . . should rest on the foundation of the most recent achievements of historic materialism" . . . "The reader will look in vain for . . . an exposure of the idealistic falsifications of modern theory in the conceptions of bourgeois scientists, or for a criticism of idealistic rudiments in the scientific work of Soviet physicists."

As a comic relief comes his charge that Ioffe failed to explain the Soviet point of view on the theory of relativity, meaning the point of view which was announced only this year (see section 3) and which stood under condemnation at the time the book was written. In short, the review does everything possible to discourage the popularization of science.

A vulnerable group

What general picture of the situation of Russian scientists emerges from all these considerations? It is safe to say that the scientists form a group critical of the official Marxist philosophy and, in turn, distrusted by the authorities—therefore, a group vulnerable to Western propaganda.

The behavior of the Soviet rulers toward them is strangely contradictory: on one hand, large sums of money are spent on research, and a high social standing is accorded to the researchers; on the other, their productivity is crippled by arbitrary interference and by petty annoyances. Undoubtedly, this curious manner of acting finds its explanation in an ambivalent mental attitude. The Russian authorities need the scientists but, at the same time, they are afraid of men who, because of their training, are able to see through the hollowness of the Stalinist claims.



Hugo Benioff and schematic drawing of his linear strain seismograph which measures squeezing and stretching in earth's crust. Instrument consists of two piers sunk in rock, almost—but not quite—joined by 100-foot fused quartz tube.

EARTHQUAKES

Seismologists move a step closer to one of their elusive goals: earthquake forecasting. They've designed a sensitive new instrument to measure the strains in the earth's crust that produce quakes.

THE CALTECH SEISMOLOGICAL LABORATORY will start construction of a sensitive new seismograph this fall, designed to record strains in the earth's crust of the order of one part in 100 million. Roughly, this means it should record a 1/1000th-of-an-inch compression in two miles of rock—or a one-inch squeeze between the Atlantic Coast and the Pacific Coast.

The instrument will be used primarily to record and measure secular (or long-term) strains in the earth's crust which produce earthquakes. This will be the first attempt anywhere at precise measurement of these strain patterns. If the experiment is successful the foundations of the science of seismology will be strengthened. At some distant date (maybe even centuries from now) these measurements—combined with the kind of intensive study that the Seismological Laboratory launched on the 1952 earthquakes in Kern County (*E&S*—October 1952)—may bring seismologists within reach of one of their elusive goals: earthquake forecasting.

Dr. Hugo Benioff, Professor of Seismology, has been awarded a $10,200 grant by the Geological Society of America for development and construction of the new instrument, which is known as a secular linear strain seismograph.

Secular strains, unlike the short-duration strains created during earthquakes, may take years or centuries

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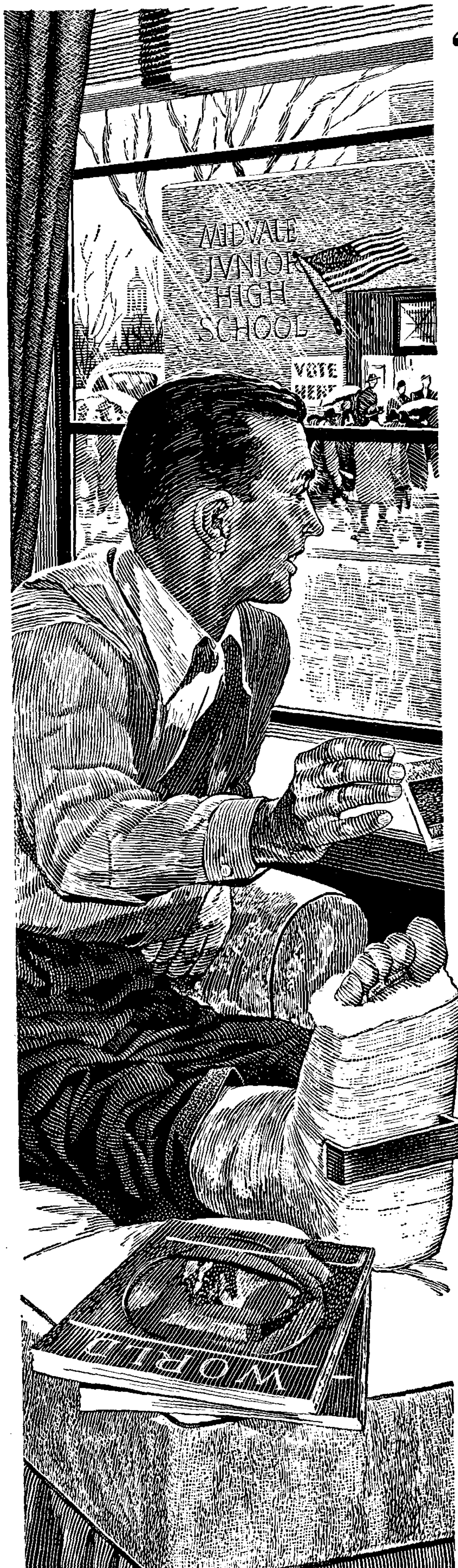

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"I say, thank God we don't live in one of those commie countries where people have only hand-picked red candidates to vote for. Those poor devils just don't get a chance to vote for anybody else. Sometimes, Mary, I think we don't fully appreciate how lucky we are. *We* vote for whom we honestly think best . . . and nobody on God's green earth knows *how* we vote!

"So hand me those crutches, Honey. And get *your* hat and coat on, too. We're going to vote together . . . bum leg or no bum leg."

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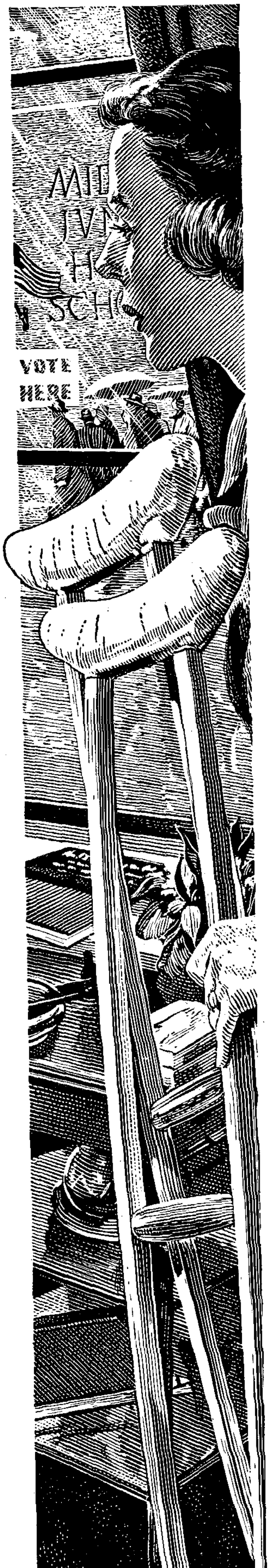

to develop. Such strains, for instance, have been building up along the northern portion of California's great San Andreas Fault since the 1906 San Francisco quake, and along the southern portion since the Fort Tejon quake of 1857. These are the strains that lead Caltech seismologists to expect the fault to slip again some day in the indeterminate future.

Secular strains accumulate when the two faces of a fault—a dynamic fracture in the earth's crust—lock by friction or "cementing" along the fault line. When enough strain energy is stored in the crustal rocks so that the resulting force breaks the obstruction, a vast, abrupt movement of rock masses occurs—in one direction on one side of the fault, and in the opposite direction on the other. This is an earthquake.

So far no instruments have been set up elsewhere to measure secular strains. The Benioff linear strain meter is intended to provide precise information on the amount of squeezing or stretching over a wide area. It will be installed in an abandoned tunnel in the San Gabriel Mountains near Big Dalton Reservoir, about 5 miles northeast of Glendora—and about 25 miles from the San Andreas Fault. The tunnel, which extends for more than 100 feet into the granite mountainside, is the property of the Los Angeles County Flood Control District. It was originally bored to determine the nature of the rock structure to which Big Dalton Dam was to be attached.

Seismograph network

If tests with this new instrument are successful, Dr. Benioff hopes eventually to establish a network of such meters throughout central and southern California. Recordings from the network would make it possible to get an overall picture of the strain pattern and its development in the area.

Seismologists then may determine the source of the basic stresses causing earthquake-producing strains. They would still not be able to predict when or where an earthquake may occur—although they would move a step closer to that distant possibility. When they have enough data to determine the amount of strain in a particular area and sufficient earthquake history to know at what strain level the fault slips, according to Dr. Benioff, it may be possible to estimate roughly when a quake can be expected. This, however, will require decades—maybe centuries—of study.

The new instrument also will be used to measure tidal strains of the earth produced by the gravitational attraction of the sun and moon. These bodies cause a slow throbbing or ground swell, just as they cause ocean tides. The period of the swell, like that of the tides, is about twelve hours. In other words, the earth's crust is pulled slightly out of shape, reaches its maximum distortion and returns to its original position over a period of one-half day.

Geophysicists have been able to determine tidal *movements* of the solid crust—finding, for instance, that the earth pulsates about eight inches at the equator —but not the tidal *strains*. These are the squeeze and stretch which produce such movements. Knowledge of the amount of tidal strain will give geologists a better idea of the structure and rigidity of the earth.

Extending the range

A third purpose of the linear strain meter is to measure and record long-period seismic waves beyond the range possible with existing instruments. Such waves are generated by large earthquakes. An early Benioff strain seismograph recorded long waves from the 1933 Japanese quake with a period of three to four minutes and later registered some with a seven-minute period from the 1950 Assam quake. Longer period waves may exist but cannot be recorded with existing instruments.

Waves of these periods provide information about the nature of the faulting at the epicenter and may indicate the duration of the processes at the source as well as the extent of faulting. They also may reveal facts about the structure of the earth's mantle down to 600 miles or more below the surface.

The new instrument will be a modification of existing ones at the Seismological Laboratory in Pasadena and at its auxiliary station on Palomar Mountain (*E&S*—November 1951). The existing instruments are designed to measure only shorter-term squeezing and stretching of the earth's crust, observed during earthquakes and their aftershocks.

Far from the madding crowd

The tunnel site will remove the new strain meter from human disturbance. (A person standing on the floor of the Laboratory in Pasadena squashes the granite bed below the building enough to record on the instrument there). Furthermore, the new meter will be well protected from temperature change. It will be made of fused quartz, which responds less to temperature variation than the steel used in earlier models at the Laboratory. And, in its tunnel location, temperature will vary less than one degree throughout the year.

The new meter will consist of a 100-foot length of two-inch fused quartz tubing rigidly fastened to a pier sunk in the rock. It will be held up by a number of flexible supports. Mounted on another pier at the free end of the tube will be specially designed electronic apparatus to measure displacement of that end with respect to the pier.

If the instrument is proved in the forthcoming test and the findings of a network of such machines are backed up by a wealth of tediously-acquired earthquake history, then it may be found that earthquakes, like all future events, may cast a *recognizable* shadow before them.

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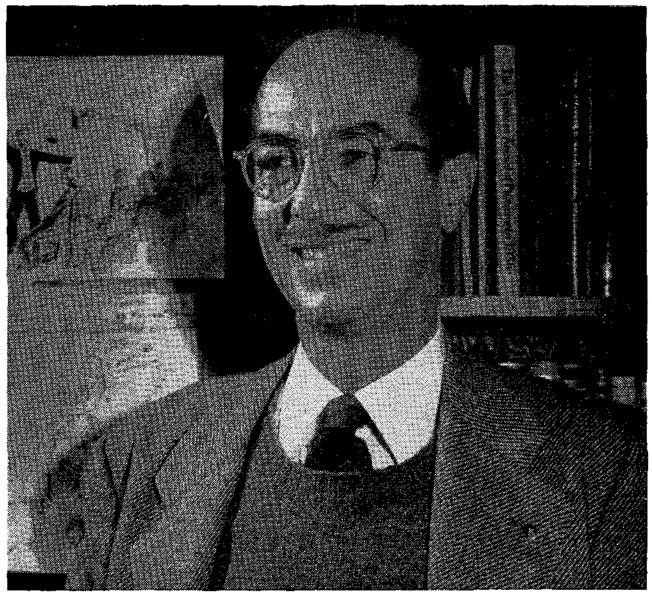

Foster Strong, Dean of Freshmen

THE MONTH AT CALTECH

New Deans

PAUL C. EATON, formerly Associate Dean for Upperclassmen, has been appointed Dean of Students, and Foster Strong, formerly Associate Dean for Freshmen, has been appointed Dean of Freshmen at the Institute.

In these newly appointed offices, Deans Eaton and Strong will retain the duties they had as associate deans, and will share between them, as well, the responsibilities formerly carried by the late Franklin Thomas, as Dean of Students.

Retiring Mathematicians

ON OCTOBER 1, Dr. William N. Birchby, Assistant Professor of Mathematics, and Dr. Luther E. Wear, Associate Professor of Mathematics, retired from the Institute. Both men had been here for 34 years.

Professor Birchby was an expert designer of mathematics examinations, and his programs for testing the knowledge of students were famous throughout the Institute. He has done research and written a number of papers in his field of analysis in mathematics.

Born near Manchester, England, he came to the United States as a small boy. He was graduated from Hope College in Holland, Michigan, and received his M. A. from Colorado College in 1905.

Before coming to Caltech in 1918 he was an instructor at Colorado College and a summer instructor at the University of Southern California. He was active on campus as Assistant Registrar, and on the Committees on Freshman Registration and Admission to Upper Classes.

Professor Wear devoted his time at the Institute to instruction rather than research. He taught mathematics to many of today's well-known scientists. In one year, 1925, his students included such outstanding men as Edwin B. McMillan, Nobel Laureate and Professor of Physics at the University of California; Nobel Laureate Carl D. Anderson, Caltech Professor of Physics; John G. Kirkwood, Professor of Chemistry and head of the Sterling Laboratory at Yale University; Alfred Foster, Professor of Mathematics at the University of California; and Charles F. Richter, Professor of Seismology at Caltech.

Professor Wear is outstanding in the field of algebraic geometry, and he is probably best known for his work on rational curves invariance under a group of transformations.

He was graduated from Cumberland University in Lebanon, Tennessee, in 1902, and received his doctorate in mathematics from Johns Hopkins in 1913. He was Professor of Mathematics at Trinity University in Texas for four years and Dean of the Faculty there for a year prior to his graduate study at Johns Hopkins. He joined the University of Washington faculty in 1913 and taught mathematics there until he came to Caltech in 1918.

He is a member of the American Association for the Advancement of Science, the American Mathematical

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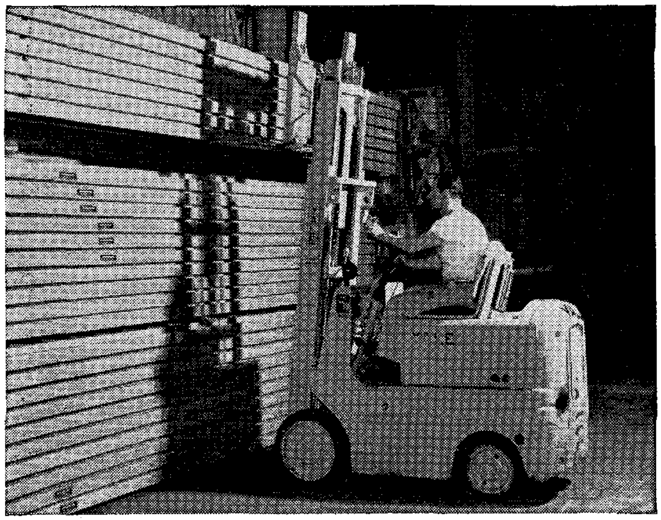
Another page for **YOUR BEARING NOTEBOOK**



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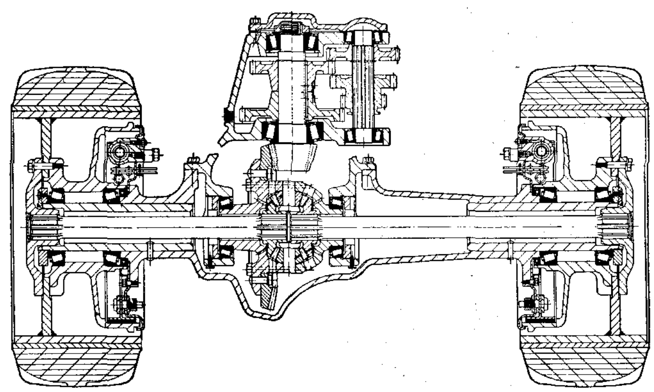

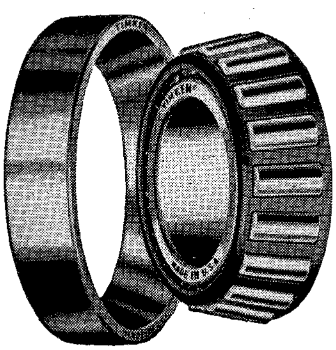

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Society, Mathematical Association of America, American Association of University Professors, Sigma Xi, and Phi Beta Kappa.

Industrial Associates Director

ROBERT V. BARTZ joined the Institute this fall as executive director of the Industrial Associates. The Caltech Industrial Associates, initiated slightly over two years ago, now include 23 member companies representing the oil, aircraft, steel, chemicals, manufacturing, and other industries.

Mr. Bartz came to Caltech from the Massachusetts Institute of Technology, where he had been director of the Industrial Liaison Office for the past four years. An M. I. T. graduate (1947), he was invited by President James R. Killian in 1948 to assist his office with industrial liaison work after serving for a year as executive aide to the director of the M. I. T. Laboratory for Nuclear Science and Engineering.

The Industrial Associates of Caltech comprise a select group of leading business concerns. Each member company supports the overall research program of the Institute and in return is kept informed on key developments and trends in areas of existing or potential importance to its business.

"It is inevitable," said Dr. DuBridge, "that this kind of relationship will grow in its effectiveness as well as in the extent of business participation. I share the conviction of many business leaders that we are witnessing here a most significant evolution of industry-university relationships into associations of much broader scope. Moreover, without compromising our role as an institution concerned with only the most basic aspects of science and engineering, I know this greater interplay with industrial research activity will greatly enliven much of our educational effort."

Gutenberg's Prize

DR. BENO GUTENBERG, Professor of Geophysics and director of the Caltech Seismological Laboratory, has been awarded the Charles Legrange Prize by the Academie Royale de Belgique, Classe des Sciences, for his geophysical research.

The prize is given every four years for achievements in geophysics. It is a cash award, given by the scientific division of the government-sponsored Belgian Academy.

Professor Gutenberg has contributed to the geophysical field through research on the structure of the earth and its core, the structural difference between continents and ocean bottoms, and propagation of sound waves in the atmosphere. During World War II, he was technical advisor for the United States Navy on the use of microseisms in the location of hurricanes and typhoons.

Sir John Cockcroft

Atomic Energy in England

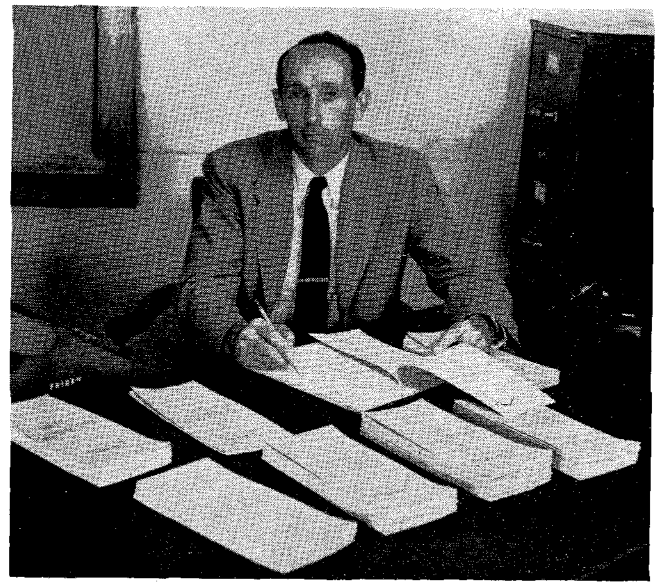
AT CALTECH last month Sir John Cockcroft, Director of the Atomic Energy Research Establishment at Harwell, England, revealed that scientists at Harwell are within ten years of developing a breeder reactor which will produce enough electrical power for all Britain.

The Harwell scientists have already heated blocks of buildings with atomic power, and the breeder is expected to use no more than 100 tons of thorium to produce electric power for the whole country.

"Use of atom energy will never be as cheap as natural resources," Sir John said, but Britain's dwindling supply of coal makes this alternative vital. Because the United States has an abundance of water power, natural gas, and cheap coal to furnish electrical energy, he noted that the use of commercial atomic energy is not nearly as glamorous in this country.

(For news of one proposal for commercial production of electric power from nuclear fuel, however, see the story on page 9 of this issue).

Sir John Cockcroft came to Caltech last month to deliver two special lectures in physics. For three years during World War II he was chief superintendent of the Air Defense Research and Development Establishment in England. In 1944 he went to Canada to direct the Montreal and Chalk River Laboratory. He has been at Harwell since 1946. In 1951 he shared the Nobel prize with Dr. Ernest Walton of Dublin for their work on splitting the lithium atom.



Dr. Weir checks returns in the Caltech alumni survey.

THE ALUMNI SURVEY

By JOHN R. WEIR

CALTECH HAS NEVER made a comprehensive alumni survey. A number of departments at the Institute have expressed a desire to have one made, but somehow no one had the time or inclination to take on the job.

When I came here last year as Associate in Psychology, this was suggested to me. There were three major reasons for wanting to conduct such a survey:

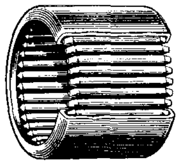
1. To verify our assumptions concerning the status, the activities and the functions of the alumnus after he has left school. These assumptions, of course, are used in setting up academic courses and procedures and, in general, in defining the total functions and objectives in the administration of the Institute. If these assumptions are not valid, as revealed by the results of the alumni survey, then it is assumed that they will be brought into line with these results.

2. To identify how and in what ways the Caltech alumnus is similar to and different from college graduates in general—this to be done by comparing the proportions of responses to the various items from the Caltech group with college graduates in general as given in the book, *They Went to College* (which you'll find described a little later in this article).

3. To evaluate the relationships between the non-academic student activities and the alumnus' accomplishments and needs which arise in his later life—in other words, to determine the extent to which non-

CONTINUED ON PAGE 46

The Torrington Needle Bearing ...designed for easy, effective lubrication



The Torrington Needle Bearing offers many design and operational advantages. High rated radial load capacity is combined with compact size and light weight. Installation is simple and fast. And one of the major advantages inherent in the Needle Bearing design is the ease with which it can be lubricated.

The full complement of small diameter rollers continuously carries a thin film of lubricant to all contact surfaces. The turned-in lips of the outer shell act as a retainer for lubricant within the bearing and effectively seal out foreign matter. Needle Bearings in many applications run for long periods of time without further attention to original lubrication.

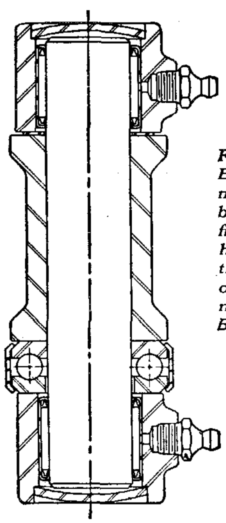


Figure 1. The Needle Bearings in this automobile king pin are lubricated with Alemite fittings through an oil hole in the center of the outer shell. These oil holes can be furnished on all Needle Bearings.

Methods of Relubrication

When Needle Bearings are shipped, they are normally protected with a high-grade slushing compound which has lubricating value at ordinary temperatures. This compound is left in the bearings in most applications.

There are several methods of providing additional lubricant to Needle Bearings:

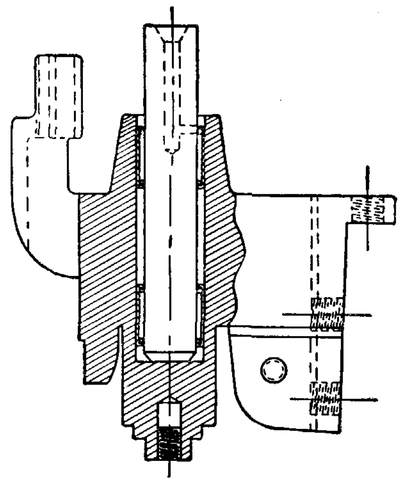


Figure 2. A hole along the axis of the shaft with a cross hole opening under the lip of the upper bearing provides lubrication to the Needle Bearings in this textile machine spindle swing bracket.

1. When lubricant is to be delivered through the housing, as in Figure 1, an oil hole is furnished in the middle of the outer shell. Care should be taken to place this hole outside the load area.

2. If it is necessary to lubricate through the shaft, a hole drilled along the shaft axis with a cross hole leading under the lip of the Needle Bearing is satisfactory. (See Figure 2.) This hole is located under the lip of the bearing rather than in the roller contact area.

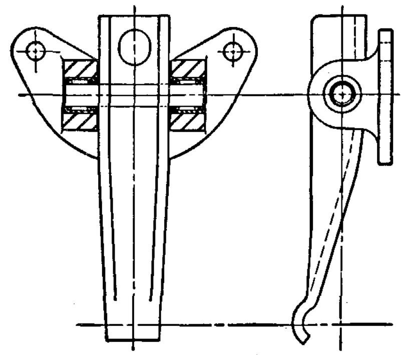


Figure 3. The Needle Bearings in the fingers of an automobile clutch are packed with grease before assembly. No additional lubrication is needed.

3. When speeds are low and loads light, Needle Bearings may be packed with grease, which often lasts for the life of the unit. Such an application is shown in Figure 3.

4. For high speeds and heavy loads, a circulating oil system is preferred, as it aids in carrying away heat as well as in providing a continuous supply of lubricant for the rollers to carry to the bearing contact surfaces. (See Figure 4.)

Selecting A Lubricant

While oil is the best lubricant, it is difficult in many cases to retain it in the bearing housing. In such cases, grease offers the best means of lubrication. In general, a soda base grease is used in the absence of moisture and a lime base grease when moisture is present. It is usually advisable to consult with a grease manufacturer before making a final decision for a particular application.

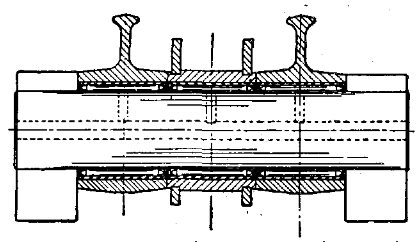


Figure 4. Heavy shock loads are easily handled by the Needle Bearings in this valve rocker arm of a large Diesel engine. Circulating oil lubrication assures a steady supply of lubricant.

If you would like more information on the use of Torrington Needle Bearings, our engineering department will be happy to help you.

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academic activities correlate with success, happiness, and satisfaction in later life.

Three institute offices were primarily concerned about having an alumni survey made—the Office of the President, the Admissions Office, and the Alumni Office. Since I was very much interested in conducting such a survey, I began to work up items for a questionnaire and to plan the design of the project. While I was in the course of doing this, the book, *They Went to College* (*E&S*—April 1952), was published.

They Went to College began as a reader survey for *Time* Magazine in 1947. It is based on a questionnaire sent out to college graduates (from the class of 1884 down to the class of 1947), which brought replies from 9,064 graduates of 1,000 colleges.

After some discussion of the relative merits of the *Time* survey, it was decided that, for several reasons, the Institute might use this same questionnaire for its survey.

Why this questionnaire?

There were several reasons for this decision:

1. Similar data collected from a Caltech alumni group would permit comparisons with the group studied in the book—this group being a random cross-section of American college graduates. This was an unusual opportunity. Comparisons of this sort are not ordinarily available, and there is always the question of interpretation of questionnaire results when there is not a second population to compare them with.

2. The questionnaire was very well planned. It had been worked out by a group of experts in this field, and was designed to permit filling out and coding with a minimum of effort.

3. There would be a considerable saving in money, since the questionnaire was already made up, and would not have to be constructed from scratch.

4. The procedure would save considerable time, for it would take a year or two to develop such a questionnaire as this one. We could obtain the questionnaire, mail it out immediately, and thus actually accomplish the alumni survey in a matter of one year rather than several.

As to the questionnaire itself: it is obviously the product of a considerable amount of thought and effort. It is organized in such a way as to permit easy coding and to require a minimum of effort on the part of the person filling it out. It also collects a broad range of basic or fundamental data and permits countless numbers of cross comparisons within the various groups.

Still, it is not *exactly* what we would have used had we developed our own. Some items obviously do not apply to Caltech alumni. Others are items which we feel are not truly important. However, a major num-

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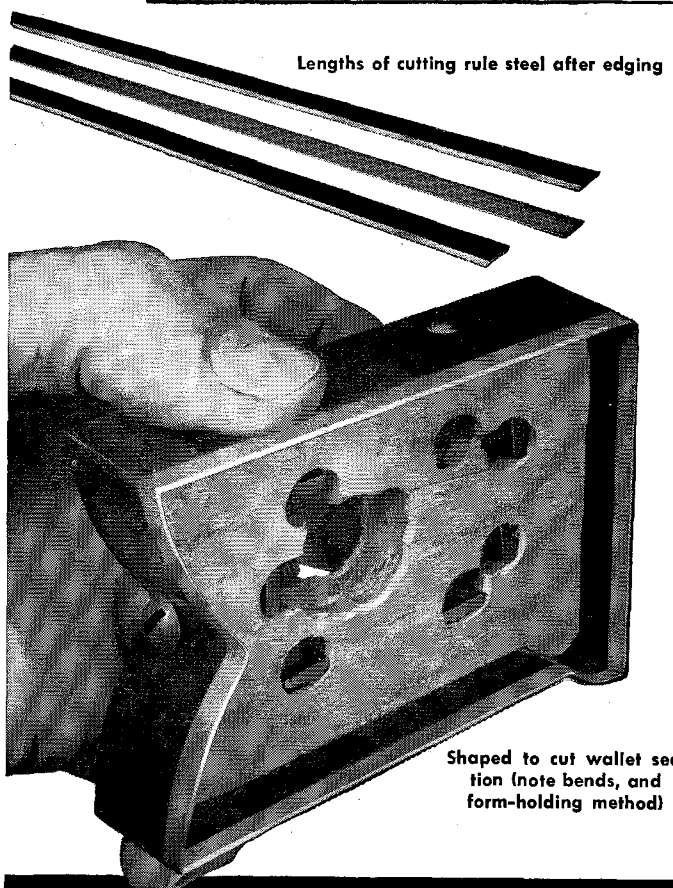
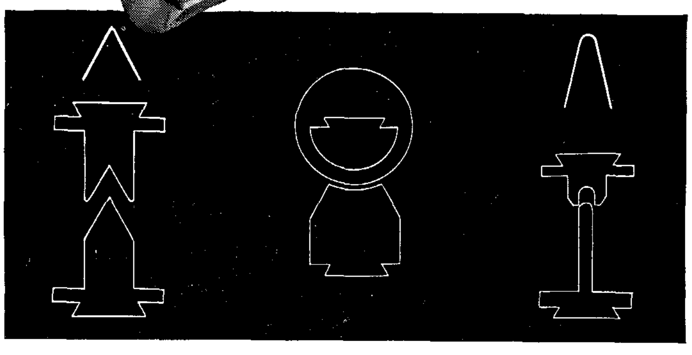
What's Happening at CRUCIBLE

about scoring and cutting rule steel



Lengths of cutting rule steel after edging

Shaped to cut wallet section (note bends, and form-holding method)



Some examples of the many shapes of bends needed

Scoring and cutting rule steel is a cold-rolled specialty steel for use in preparing dies for cutting paper, leather, rubber and other materials.

It is a pre-tempered product manufactured by skilled workmen, using precision rolling and hardening equipment, to close limits for chemistry, grain size and hardness. This product must also be capable of meeting intricate bend requirements in the hardened and tempered condition.

This specialty is furnished with round edges and in coil form to the rule manufacturer who grinds the edges — the one edge square and the other to a knife edge as well as cutting the material into desired lengths. This is sold to a die-maker who bends the rule to the required shape. This is then the nucleus of a pre-hardened die, which when properly brazed and supported is used to cut out material for display cards — aircraft parts — pocketbooks — wallets — gloves — gaskets — washers.

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ber of items in the questionnaire are of extreme value and interest to us, and we feel that this questionnaire essentially accomplishes the purpose we had in mind.

Questionnaires were mailed to all Caltech alumni in the latter part of July of this year. They went to all graduate, undergraduate, and foreign alumni. Every effort has been made to keep the questionnaire returns completely confidential. The alumnus' name was on the questionnaire when it was mailed out, but this was done solely to permit a follow-up letter to be sent to those alumni who did not return the questionnaire within 30 days of the date of the initial mailing.

When the questionnaire is returned, the name of the alumnus on the back of the questionnaire is obliterated; thus, there is no way in which an individual questionnaire can be identified. The questionnaire data are considered to be entirely confidential and are not seen by any one on the campus except myself and my assistant.

The results to date have been very gratifying. There were 5,640 questionnaires mailed out the latter part of July. Up to the middle of October, 3,609 had been returned as completed. This represents approximately 64 percent of the original sample. Returns are continuing to come in—up to a dozen a week—and I expect that we will end up with somewhere around 67 to 70 percent. This is an excellent return. The *Time* questionnaire survey got only 55.6 percent return, in spite of the use of several additional procedures which we do not contemplate using.

Alumni who have not as yet completed their questionnaires are encouraged to do so. There is no deadline for their return. In addition, if any alumnus has not completed and returned a questionnaire and wishes another one—having lost his initial one—he can write to either *Engineering and Science* or to me and another copy will be sent immediately.

The job now is one of coding the items of the questionnaire, punching them into IBM cards, and tabulating the results. All results will be reported in terms of percentages of the total group. This is the same method used in the *They Went to College* study.

It took *Time* Magazine four years from the mailing of the questionnaires to the publishing of the book, and involved approximately 9,000 questionnaires. We have, in our survey, approximately 3,700 questionnaires and have high hopes of completing the work in about a year. The present plan is to publish the results in *Engineering and Science*, in several separate reports, each report covering certain related aspects of the data collected in the questionnaire.

PERSONALS

1918

H. Darwin Kirschman, M.S. '19, Ph.D. '29, has joined the technical staff of Truesdail Laboratories in Los Angeles as a research chemist. He had been serving as a lecturer in chemistry at the University of California.

1922

Harold R. Harris, Pan American's chief of Atlantic operations, will become president of Northwest Airlines on January 1, 1953. We can thank *Time* Magazine for the most detailed account of Hal's activities since his graduation. The October 20 issue says: "A graduate of Caltech and a World War I flyer, Hal Harris was made chief Army test pilot after the war. In 1922, when the wings of a plane he was flying dropped off in mid-air, he became the first Army pilot to parachute to safety from a disabled plane. Harris racked up 13 air records, test-piloted the first big U. S. bomber in 1922, the six-engine Barling. In 1926 he went to Peru, and flew crop-dusting planes, later became vice president and general manager of Peruvian Airways and from 1929-42 was operations manager of Panagra. Made a brigadier general in World War II, he bossed the training and domestic operations of the Air Transport Command, later managed operations for American Overseas Airlines until it merged with Pan Am in 1950."

1924

Roy O. Elmore writes that his daughter, Sally Ann, married Carroll R. Lindholm '51, on July 6. Carroll is working for Motorola as a field engineer in the Chicago office.

Rex S. Clark, Ex., writes that he is still an invalid with multiple sclerosis. His son, now 24, is working on his M.A. at Syracuse, and is marrying a Los Angeles girl in December.

David Wolochow, formerly on the alumni-missing-in-action list, has turned up as secretary of the Canadian Government's Specifications Board of the National Research Council in Ottawa, Canada.

1925

Albert Chapman and his family returned to the States from Venezuela in the spring of 1950 after over four years there. He joined the Plant Engineering Office of the Ford Motor Company Manufacturing Staff as staff mechanical engineer, and in February, 1952, was appointed manager of the engineering and planning department. This department has the responsibiilty for all Ford Motor Company new construction, and staff supervision over plant engineering.

It's the first time in any of the Chapmans' lives that they've had to live in a cold climate. Though they don't really mind it, if they had their druthers, Susan (14) and Betsy (16) Chapman druther live in Texas. They haven't tried southern California yet.

1926

Bruno R. Schabarum died of a heart ailment near Estes Park, Colorado, on June 11. Bruno was elected early this year to the presidency of the Carl B. King Drilling Company in Midland, Texas.

Col. Alvin G. Viney, Ex., previously stationed with the Office of the Secretary of Defense in Washington, D. C., has been appointed deputy chief of the Engineer Division of the European Command Communications Zone in France. The Zone is responsihle for the transportation of men and supplies from French ports to U. S. forces in Germany. Its headquarters are in Orleans.

Col. Viney is a graduate of the United States Military Academy and the University of California. A former resident of Vista, Calif., he has earned the Legion of Merit, the Bronze Star Medal, the French Croix de Guerre and the Belgian Order of Leopold.

1927

Layton Stanton, Ph.D. '31, in charge of geological work for the Union Oil Company in the Sacramento area, christened a new swimming pool at his Sacramento home on Sunday, September 21. Before the day was over, about 20 Tech alumni and their wives had tried out the new pool—including *Tracy Atherton* '25, *Mervin Schuhart* '32, *Homer Scott* '34, *Luther Eastman* '28, *E. S. Ida* '46, *Richard Silverstine* '41, M.S. '42 *H. T. Nies* '23, *Fred Groat* '24, *Layton Stanton* '27, Ph.D. '31, and *Prof. Royal W. Sorensen*.

1928

Walter H. Righter has been president of the L. A. Pneumatic Company, Inc. for about a year. It's a job machine shop and also does development engineering in pneumatic and hydraulic fields. Walt says he still has the same wife, an older daughter who was married this year, and another daughter who is going to the University of Redlands.

Russell J. Love, formerly vice president of Standard Steel Corporation, is now chief consulting engineer at the Naval Ordnance Test Station in Pasadena. His son James was graduated from Stanford in June. His daughter Patti was mar-

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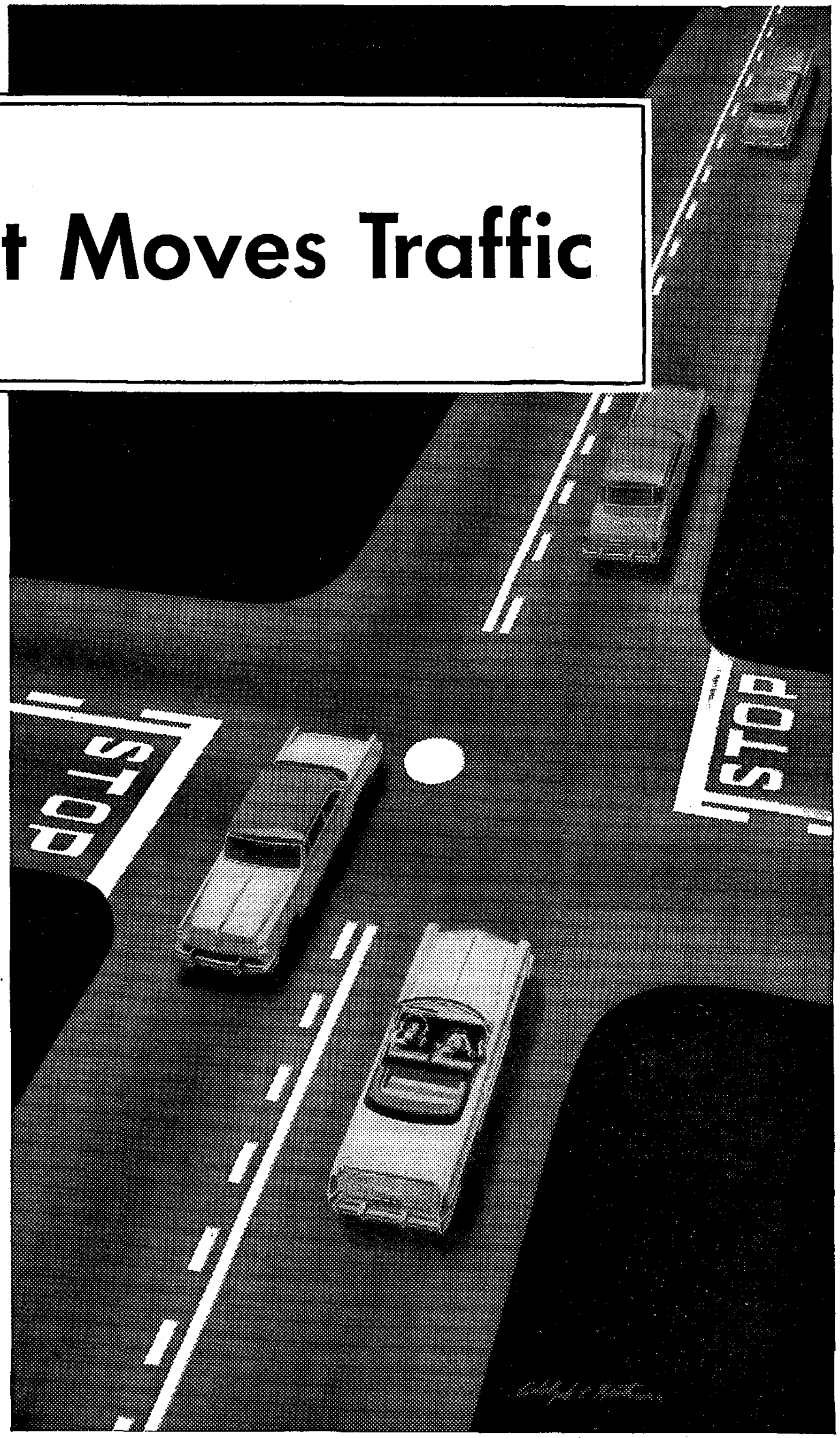
Paint That Moves Traffic



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SOLUTION...

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ried in June to Jerry E. Bryant, Jr. of Deerfield, Illinois. Both had attended the University of Arizona at Tucson.

Martin E. Nordberg, Ph. D., research chemist of the Corning Glass Works, was awarded a John Price Wetherill Medal by the Franklin Institute of Philadelphia on October 15. With Harrison P. Hood, also a research chemist at Corning, Dr. Nordberg was honored for the discovery of a new process for manufacturing glass. He has been with Corning since 1929.

1929

Ernest B. Hugg, M.S. '30, has a baby daughter, Beverly Linda—born April 6, 1952. Ernie, who is Assistant Superintendent of Buildings and Grounds at Caltech, is also president of the Caltech Employees Federal Credit Union, which now has deposits of over $250,000.

1930

Tom G. Bernhardi was one of 47 business men to receive a Master of Business Administration from the University of Chicago in June. Tom graduated with a record of 11 A's and one B. He is working as chief engineer in the process division of the Whiting Corp.

1931

Stephen C. Dorman has left the Shell Oil Company in Modesto, where he was Senior Entomologist, and will continue research with the Stauffer Chemical Company in Mountain View, Calif., on agricultural applications of chemicals.

Myron L. Crater has been Chief Steam Plant Engineer of the City of Glendale, California, for eleven years. He is married and has two daughters, Marjorie and Margaret.

1933

J. Stanley Johnson, M. S. '34, writes that the Holly Manufacturing Company, of which he is president, has been collaborating with the Coleman Engineering Company (Ted Coleman '26) under the joint-venture name of Holly-Coleman Company. The company is set up to produce aircraft starters for the Navy. Their sample starters, Stan says, broke a record of long standing by being accepted without any changes whatsoever.

Charles D. Perrine, Jr. was appointed assistant division manager of Convair's Guided Missile Division in Pomona recently. He joined Convair in October, 1950, as staff assistant in the San Diego Division electronics and guidance section. Before coming to Convair, Charlie was manager of the electronics department of the Fairchild Engine and Airplane Corporation's guided missiles division in Farmingdale, New York.

1934

Glenn W. Weaver has been with the Research and Development Laboratories of the Hughes Aircraft Company at Culver City for the past year. At present he is Assistant Head of the Computers and Controls Department of the Guided Missile Laboratories.

1935

Donald C. Webster left the Naval Ordnance Test Station in Pasadena in January, 1951, to become chief engineer of Librascope, Inc. in Glendale. But the big news, Don says, is that he just traded the old Ford in on an MG. Driving an MG is an experience which he recommends to all old grads who need to relax.

John B. Higley dropped by the campus this fall while on a one-month visit with his family in this area. He's living in Newton Center, Mass., and works as Section Head of the Engineering Division of the American Machine and Foundry Co. in Boston.

1937

John W. George has been transferred to the New York offices of the Union Carbide & Carbon Corp., after 12 years in the field with Carbide's mining subsidiary, United States Vanadium Co. He's now Assistant Manager of Carbide's Personnel Department.

1938

Newman A. Hall, Ph.D., is on leave from the University of Minnesota this year, serving as Director of the Division of Engineering Sciences of the Officer of Ordnance Research.

1939

David H. Scott, supervisor of the Texas Co.'s geophysical operations in the Pacific Coast division, producing department, has been transferred to the Houston geophysical office as head of the gravity staff.

1940

Bob Wallace, Ph.D. '46, announced the arrival of a son, Alan Ryan, on August 25, 1952.

Herbert Worcester, Jr., is still chief engineer for the Pacific Wire Rope Company in Los Angeles. He has two children—Jim, 3½, and Jane, 2.

Frank Dessel, M.S. '43, and his wife gave a cocktail party for *Lloyd Goodmanson*, '40, M.S. '41, and Elinore Goodmanson last August 17 at their home in San Marino. Over 100 Caltech alumni and their wives came—mostly from the classes of '39 and '40. The Goodmansons were

CONTINUED ON PAGE 54

visiting here from Seattle. Lloyd and Frank were roommates in Ricketts.

Kiyo Tomiyasu has been promoted to engineering section head for microwave research at the Sperry Gyroscope Company. In 1941, Kiyo received his M.S. degree from Columbia, and after studying briefly at Stanford University under a Low Scholarship, he was self-employed. In 1944, he entered Harvard University to continue graduate work under a Gordon McKay scholarship for two years. He then served as a teaching fellow for one year and a research assistant for another year. After receiving his Ph.D. in 1948 he served a year as an instructor at Harvard before going to Sperry. Since joining Sperry he has been occupied chiefly in microwave spectroscopy as well as in research and development of wave-guide components for radar systems.

1941

William J. Wagner still works for the Shell Oil Company, but has been transferred from Long Beach to Ventura, Calif.

Delbert D. Thomas has a new position with Mathieson Chemical Company which has taken him to Niagara Falls, New York.

Harold K. Fink, M.S., has moved from Poway, Calif. to La Jolla, where he is a psychoanalytic psychotherapist.

1942

LCdr. Thomas G. Atkinson was recalled to duty in the Navy in May, 1951, and is at present assigned to construction contract administration duty at NAS Miramar, San Diego, Calif. He expects to follow his former occupation in structural engineering or related fields when and if he is released next year.

Peter L. Nichols, Jr., Ph.D., has been employed by JPL since June of 1950.

Herbert G. Osborne spent the summer as a resident engineer at the Lagnna Canyon storm drain for the Orange County Flood Control District.

Carol M. Veronda has been promoted to engineering section head for high power klystrons in the Sperry Gyroscope Company. Carol joined Sperry in 1948 as a project engineer and in 1950 became senior project engineer.

1943

M. Curtis Smith, M.S. '46, has been working at JPL since June, 1951. The Smiths built a new home in Flintridge, and moved in last July. Their first offspring—a boy named Craig Curtis—arrived last May 27.

1944

William P. Bair and Barbara Bostwick were married on August 23 in St. Edmund's Episcopal Church in San Marino. Barbara is a graduate of Occidental College and worked as a research assistant at Caltech's Arcadia Farm under Dr. E. G. Anderson. Bill is teaching mathematics at Wilson Junior High School in Pasadena, and doing graduate work at Occidental.

Richard A. Hudson won a Fulbright Scholarship to study pipe organ for a year at the University of Amsterdam. The scholarship includes return passage, tuition and maintenance while pursuing his studies. Dick sailed on August 1.

Phillip L. Adams was married on September 6 to a Sarah Lawrence graduate (no name given) whom he met in Paris. They are living in Orleans, France.

Wheeler North, '50, married Nance Fountain on August 15, 1952.

Donald T. Greenwood, M.S. '48, Ph.D. '51, is working at Lockheed Aircraft in Burbank. His job is the operation of analog computers.

1946

John O. Nigra, M.S., has been appointed Associate Professor of Geology at the College of Arts and Sciences of Tulane University in New Orleans. He recently resigned as research geologist for the Arabian American Oil Company in New York City.

Rev. Albert O. Klein, recently graduated from the Fuller Theological Seminary, was married this summer to Carol Moore of Pasadena. The Kleins are now making their home in Sacramento.

1947

Arthur S. Bolles has been employed by "Aramco" in Dhahran, Saudi-Arabia, since 1948. In November, 1950, he married Marjorie Williams of Chicago, a graduate of Illinois Wesleyan, who was employed by Aramco in the petroleum laboratory in Dhahran. They spent three months in 1951 vacationing in the United States, travelling via Egypt, Italy and France. On July 7, 1952, Roy Frederick Bolles arrived in Dhahran, weighing in at six pounds. The Bolleses enjoy life in the American colony at Dhahran, and Arthur finds the work so interesting that he plans to stay through many more contracts.

1948

Allen T. Puder, M.S. '49, is the father of a boy, born last August 29, and named Allen Brent.

Lt. John P. Davis, M.S., and Joan Lee McKenna were married in San Gabriel last summer. They settled down, temporarily, in Vallejo, but planned to make their home in Honolulu.

Lt. Col. Roy S. Kelley, M.S., is now attending the Army Command and General Staff College at Fort Leavenworth, Kansas. He is one of 598 officers—from every branch of the U. S. Armed Forces and 29 foreign nations—who began the ten-month course on September 3. Roy entered the Army in 1941 and has collected a good many decorations since then—including the Bronze Star Medal, American Defense Service Medal, Army of Occupation Medal for service in Germany, American Theatre Ribbon, European-African Middle Eastern Campaign Medal with four campaign stars and the World War II Victory Medal.

Philip R. Conrath was killed in an automobile accident on August 17. Since graduation, Phil had been an aeronautical engineer with the McDonnell Aircraft Corporation in St. Louis.

1949

Don Six married Ruth Ann DeKemper of Mount Vernon, Indiana, last July. Ruth is a graduate of the University of Indiana. The Sixes are living in Walnut Creek, Calif.

Don Hibbard has been transferred by the Army from AEC's Nevada Proving Ground near Las Vegas to Washington, D.C. In Nevada he and another G. I. geologist were assigned the job of mapping the geology of the area, and they are now writing up the report during their last days in the Army.

This month the Hibbards plan to leave on a one or two-month vacation in Mexico City and Yucatan. On his return, Don will go to work with an oil company.

Robert L. Fisher is working toward a Ph.D. in oceanography at Scripps Institution of Oceanography in La Jolla. He spent the summer months largely aboard a ship off the coast of Mexico and Central America studying foredeeps. He plans to leave in November on a three-month trip to the South Central Pacific.

Roy W. Gould married Ethel (Bunny) Stratton on August 23 in a garden wedding at the home of the bride's parents in Pasadena. Bunny is an alumna of Westridge and Vassar. Caltech alumni serving as ushers were Edward DuFort '49, best man, and Phil Lamson '48, and Hugh Carter '49.

1950

Dean A. Rains, M.S. '51, is doing graduate work at Caltech on a Guggenheim Jet Propulsion Fellowship. His fellowship was one of nine made at Caltech to "train young men for basic research and leadership in the development of commercial and scientific applications of jet and rocket propulsion." Dean, who is

ALUMNI CALENDAR

- November 13 — Oxy-Caltech Kickoff Luncheon, Athenaeum
- November 14 — Open House, Dabney Hall of Humanities
- January — Dinner Meeting, Long Beach area
- February — Dinner Dance
- March — Dinner Meeting, Santa Monica area
- April — Annual Seminar
- June — Annual Dinner Meeting
- June — Annual Family Picnic

CALTECH ATHLETIC SCHEDULE

VARSITY FOOTBALL

Nov. 8 Bye

Nov. 14, 8 p.m.
Occidental at Occidental

Nov. 21, 8 p.m.
Cal Poly (S.D.) at Covina High

FROSH FOOTBALL

Nov. 15, 2:00 p.m.
Whittier at Caltech

CROSS COUNTRY

Nov. 7, 4:15 p.m.
Redlands at Caltech

Nov. 14, 4:15 p.m.
Whittier at Caltech

Nov. 21, 4:15 p.m.
Caltech at Pomona

FRIDAY EVENING DEMONSTRATION LECTURES

7:30 p.m.—201 Bridge

Nov. 7 "The Science of Fly Fishing" by Professor W. W. Michael

Nov. 14 "Building to Withstand Earthquakes" by Professor G. W. Housner

Nov. 21 "The Caltech Synchrotoron" by Professor R. F. Bacher

working for his Ph.D. degree, is married and the father of a baby girl.

Peter Howell was married on June 15 to Gladys Fundstrom, a graduate in music from the University of Minnesota. Ralph Lovberg '50 was at the wedding and took pictures. Pete and his wife spent the summer at the Naval Ordnance Test Station in Inyokern where he researched for the Navy. He's now back at the University of Minnesota, working for a Ph.D. in physical chemistry and doing X-ray crystallography work.

1951

Barrie Bieler, M.S. '52, spent the summer in the Aleutian Islands working for the U. S. Geological Survey on a reconnaissance field mapping program. Now he's studying for his doctorate at Penn State College.

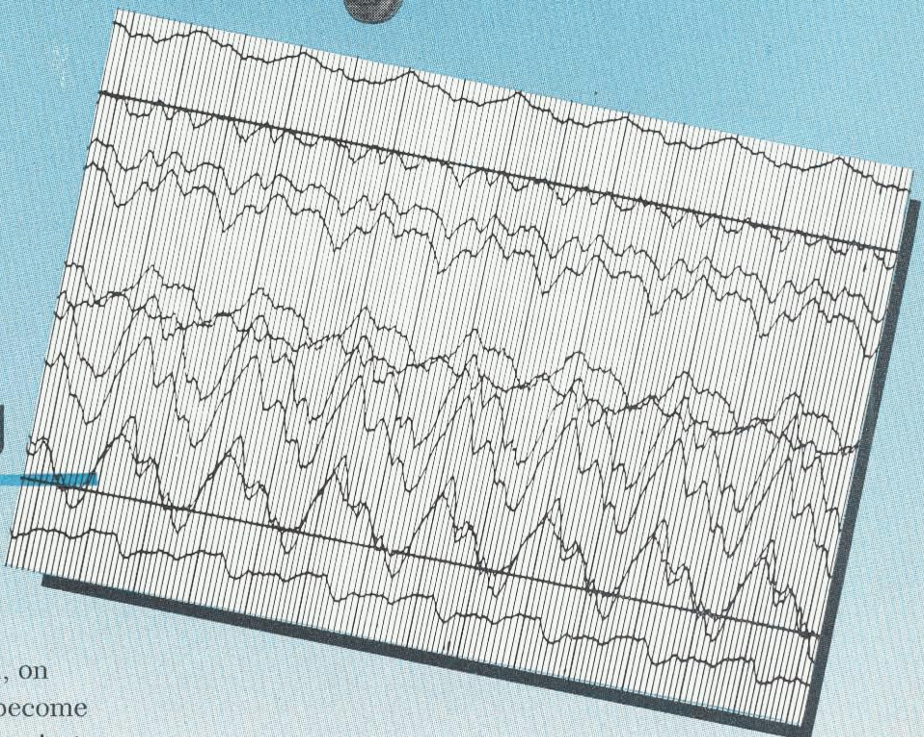
W. F. Sampson reports the arrival of a baby boy, William Frederick, on August 13. The Sampsons are living in Altadena, and Bill is working at JPL.

Robert DeGrasse was married in August to Marilyn Haglund of San Gabriel. *Kyle Catterlin* '52, was one of Bob's ushers for the event. The Degrasses now live in Los Angeles.

1952

Bill Wise and his wife Jacy, announced the arrival of a son, Lawrence Alan, on September 13. Bill and his family live in Palo Alto.

Photography...
an able helper all through engineering



These traces provide helicopter engineers with information about blade stresses during flight. Strain gages pick up bending at different locations. Photography with its perfect memory catches the whole story as fast as it happens.

In the laboratory, in the drafting room, on the production line, photography has become a most important tool. It records fleeting instrument traces for study. It examines metal structure through electron micrography, x-ray diffraction, and microradiography.

The use of photography in engineering, business, and industry is increasing steadily. This has led graduates in the physical sciences and in engineering to find positions with the Eastman Kodak Company. If you are interested, write to Business and Technical Personnel Department, Eastman Kodak Company, Rochester 4, N. Y.

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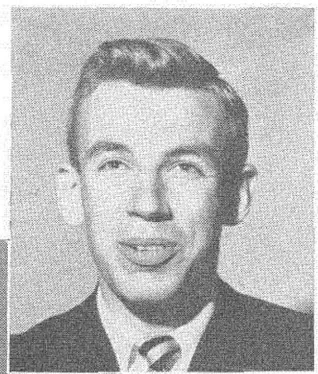
MY QUESTION TO THE G-E STUDENT INFORMATION PANEL:

"What is General Electric's policy on employment in light of the draft?"

. . . John C. Bennett, University of Rochester, 1953



The answers to John Bennett's question - - excerpts taken from the panel discussion - - are given below.

R. J. CANNING, *Business Training Department* . . . Basically, the Company is interviewing and considering college students for employment without regard to their draft status. We're not passing over men because they are eligible for the draft—we're hiring them if they have the qualifications we want in our employees. We are looking at the area of employment on a long-range basis, and we think we are going to carry a perpetual inventory of men in the armed forces for a considerable period of time. It's true we lose some men, but we get many back, and with this in mind our policy is based on personal qualifications, not on draft eligibility.

J. L. MICHAELSON, *General Engineering Laboratory* . . . We are experiencing a growing appreciation of the importance of an adequate supply of well-trained professional people to this country's immediate and future welfare. Although this situation creates excellent opportunities for you students for future employment, the draft may leave you plagued by uncertainty for the present. But, remember this, we are not only considering college people for employment entirely for the year 1952. We are also thinking ahead to the years '54, '55, and '56, and if we find a good man now, knowing he is going into military service, we will still make long-range employment plans for him. We still would like to have him come with us after he has completed his military service.

M. M. BORING, *Engineering Services Division* . . . Whether or not you are called into military service you can reasonably expect to follow your profession for approximately 30 or 40 years. Your solution to the many problems, such as this one, which arise during your entire productive period, will be a lifetime undertaking. A period spent serving your country in a military way will represent a relatively small part of your total professional life. The way you handle a problem such as this, and the information you get to help in its solution, will determine to a large extent your ability to handle future problems.

Now, where does General Electric stand in regard to this draft situation? This is our policy. Regardless of military status, we desire to interview all students who are interested in our Company. And, irrespective of military status, we will make employment offers to all who have the qualifications we are looking for, and whom we would like to have become members of the General Electric family. If any of these people are called into service before starting work with us, business conditions permitting, our offers will be waiting for them when they return. Those with us before being called into service will maintain continuity, and, barring unforeseen circumstances, will be assured of employment upon return.

Following World War II we did not have to go back on a single promise. When the present world situation is concluded we hope our record will remain the same.

Do you have a question—or seek further information? If so, write to College Editor, Dept. 221-6, General Electric Co., Schenectady 5, N. Y.

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