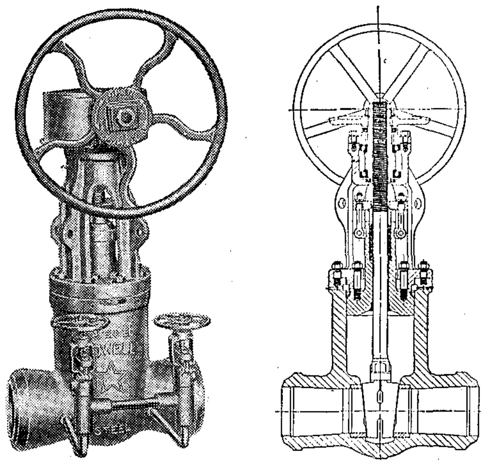
# ENGINEERING | AND | SCIENCE

FEBRUARY/1951

*Public Affairs Room . . . page 22*

PUBLISHED AT THE CALIFORNIA INSTITUTE OF TECHNOLOGY

*Another page for* **YOUR BEARING NOTEBOOK**



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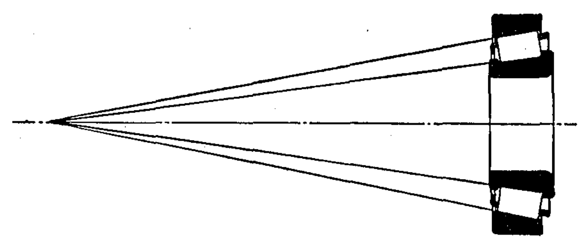

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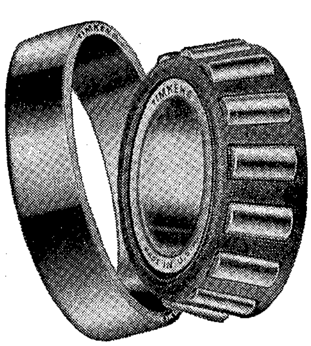

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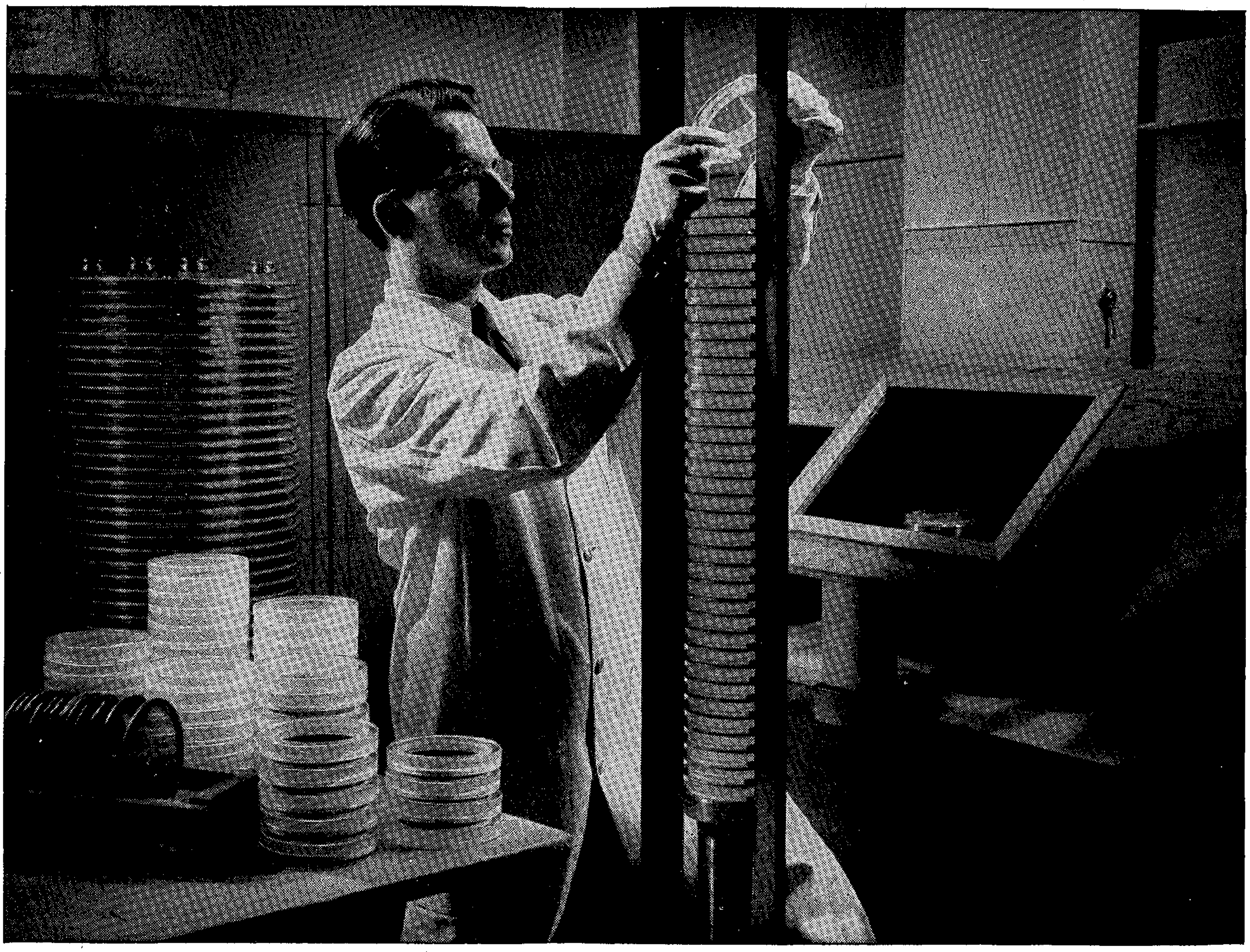

# A gun barrel made of glass...

**This scientist** is putting together the barrel of an "electron gun." When completed, it will be capable of developing cancer-killing rays at twice the power of those given off by all the medical radium in the world.

The barrel of the gun, part of a new super-voltage X-ray machine used in cancer research and treatment, is a tube formed by stacking precision-made rings of one of Corning's special electrical glasses.

Two million volts drive electrons through the tube, much as a bullet is driven through a gun barrel. As these electrons are suddenly stopped by a water-cooled block of gold at the end of the barrel, two-million-volt X-rays are generated. This X-ray beam is powerful enough to reach diseased areas four inches inside the body and it can be directed with great accuracy on the spot the doctor wants to bombard.

High Voltage Engineering Corporation, manufacturers of this generator, at first had difficulty finding a high-voltage electrical insulating material for the gun barrel, a material that would stand electron bombardment hour after hour without breaking down. The answer to their problem was a glass selected from the many developed by Corning to meet exacting electrical specifications.

Providing glass for medical research is not new to Corning. Since the early days of X-rays, glass by Corning has played a vital part in the development of X-ray apparatus —transmitting glasses for tubes and absorbing glasses for shields. And Pyrex brand laboratory and pharmaceutical glassware has served medical science since World War I.

Throughout industry, *Corning means research in glass*—research that has contributed in countless ways to better products and processes, and through them, to better living for us all.

**That's why we suggest**—when you're out of college and concerned with improving products or processes—that you consider glass, a material of practically limitless uses. And should you want to know more about Corning electrical glasses, or the hundreds of other glasses Corning makes, we hope you'll write us before your planning reaches the blueprint stage. Corning Glass Works, Corning, New York.

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**means research in glass**

Future-minded planning will keep operating budgets low in the

# NEW FLORSHEIM "DREAM HOME"

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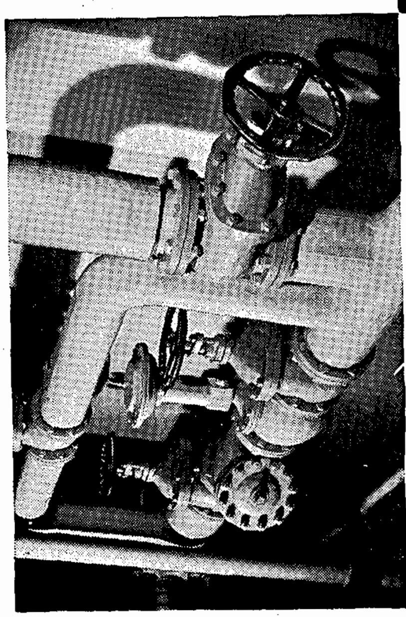

**Among the 1022 Jenkins Valves** installed in The Florsheim Shoe Company's combined factory-and-office building are these gate valves in the steam distribution lines of the heating system. Other Jenkins bronze, iron, and steel valves control water, air-conditioning, and such vital lines.

With its unbroken horizontal tiers of grey brick curtain walls which "seem to float in thin air", acres of glass their only visible means of support, the new home of The Florsheim Shoe Company in Chicago might be called an industrial "dream home".

It is certainly one of America's most notable examples of future-minded planning. Like the production machines used in cutting, lasting, stitching, and finishing Florsheim Shoes, the equipment installed for building operation is the most efficient modern engineering has devised. Here, Jenkins Valves "fit perfectly".

In fact, because of their dependability, safety and lasting economy, Jenkins Valves have been the choice, consistently, of leading architects, engineers and contractors for the towering skyscrapers, huge industrial plants, and super airports that are making today's building news.

They know Jenkins builds extra endurance into valves — proved by low upkeep cost records in every type of service. Yet, despite this extra value, *they pay no more* for Jenkins Valves. For new installations, for all replacements, the Jenkins Diamond is their guide to lasting valve economy.
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# ENGINEERING AND SCIENCE

## IN THIS ISSUE

THE TWO STUDENTS on this month's cover are poring over some of the literature in the Institute's new Public Affairs Room. For more about this welcome addition to the campus see page 22.

PRESIDENT DUBRIDGE'S statement on "Students and the Draft" (page 5) was issued last month to the *California Tech*, after he returned from meetings in Washington of the Scientific Manpower Advisory Commission of the NSRB.

"CLOUD SEEDING" (page 7) was written by three Caltech alumni who have recently organized as North American Weather Consultants in Pasadena—to perform cloud seeding operations, furnish weather forecasts and do applied research in cloud physics, climatology, oceanography and aeronautical meteorology. Eugene Bollay received his M.S. in Meteorology from the Institute in 1936; Robert D. Elliott received a B.S. in Physics in 1936, and an M.S. in Meteorology in 1937; Paul B. MacCready, Jr. got his M.S. in Physics in 1948, and is now working towards his doctorate.

AS NOBODY NEEDS to be told, William W. Michael, Professor of Civil Engineering at the Institute, is one of the world's best fishermen. What is news, though, is that he's written a book about fishing. McGraw-Hill publishes it in April, it's called "Dry-Fly Trout Fishing," and the article on page 13 is an excerpt from it.

**PICTURE CREDITS**

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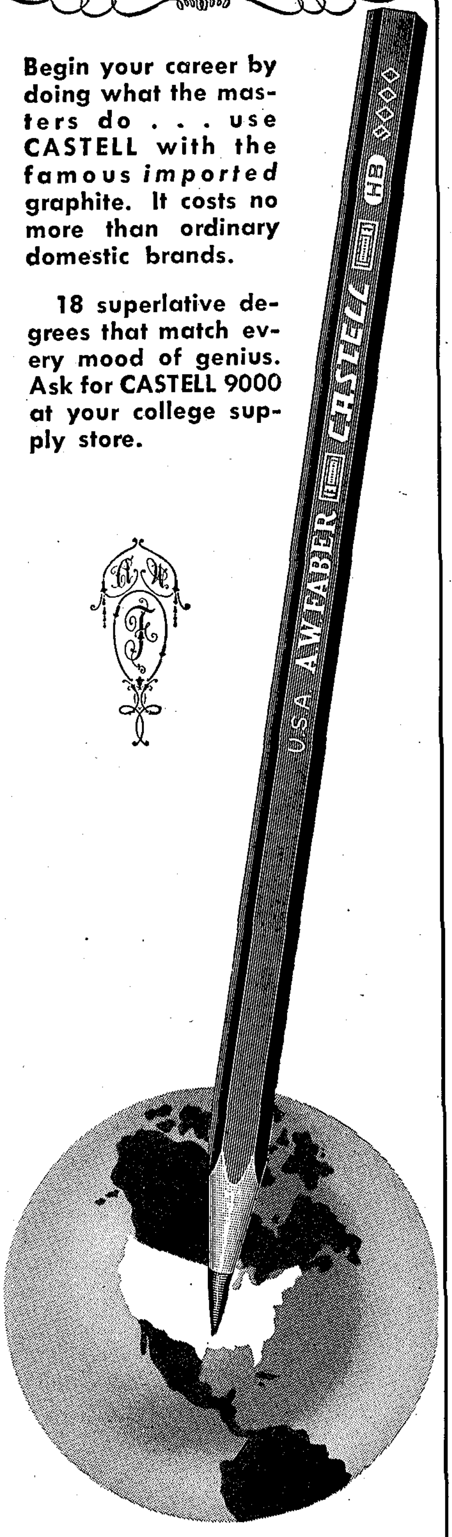


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# BOOKS

### THE HELL BOMB

by William L. Laurence
Alfred A. Knopf $2.75

WILLIAM L. LAURENCE is science news reporter for the New York *Times*, a journalistic expert on atomic energy, and the only newspaper man who was privileged to be present when the first atomic bomb was set off at Alamogordo. In this book he has gathered all the published, and publishable, information about the hydrogen bomb and come to some "technical conclusions reached by deduction based on these published facts and theory, for which I assume the sole responsibility."

Mr. Laurence comes close to his goal of making this subject understandable to the layman as long as he is describing the makeup of the hydrogen bomb, or discussing the problems that must be faced in its construction and possible detonation, or when he is presenting a primer of atomic energy—as he does in the last chapter of the book. But his conclusions are something else again.

Mr. Laurence, for instance, makes quite a case for the hydrogen bomb as a military weapon—though most scientists who are fully informed on the bomb have been trying to show how and why it is a weapon whose effectiveness has been grossly exaggerated, and one on which we can place little reliance for the future. Mr. Laurence believes that "the advent of the H Bomb constitutes the greatest threat to the survival of the human race since the black death"—though scientists have been trying to explain that this is a remote possibility rather than a probability.

As Mr. Laurence says, of course, he assumes sole responsibility for these conclusions. He is, in fact, alone in many of them; few fully-informed scientists would agree with him. Unfortunately, few of the laymen who read his book will be well-enough informed to know that.

### MATHEMATICS, QUEEN AND SERVANT OF SCIENCE

by Eric Temple Bell
McGraw-Hill, New York $5

THIS IS A REVISION and amplification of two popular accounts of mathematics written by Dr. Bell in 1931 (*The Queen of the Sciences*) and 1937 (*The Handmaiden of the Sciences*).

In an introduction, Dr. Bell, Professor of Mathematics at the California Institute, explains that his book is not intended to be a substitute for a textbook, or a treatise on any subject in either pure or applied mathematics, but merely an attempt to explain to the interested layman something of the spirit of modern mathematics.

By describing some of the developments in both pure and applied mathematics in the last century Dr. Bell's new book provides a stimulating extension course for anyone who has been introduced to antique mathematics in secondary school and who still retains some interest in what happened after that.

### THE HUMAN USE OF HUMAN BEINGS

by Norbert Wiener
Houghton Mifflin, Boston $3.00

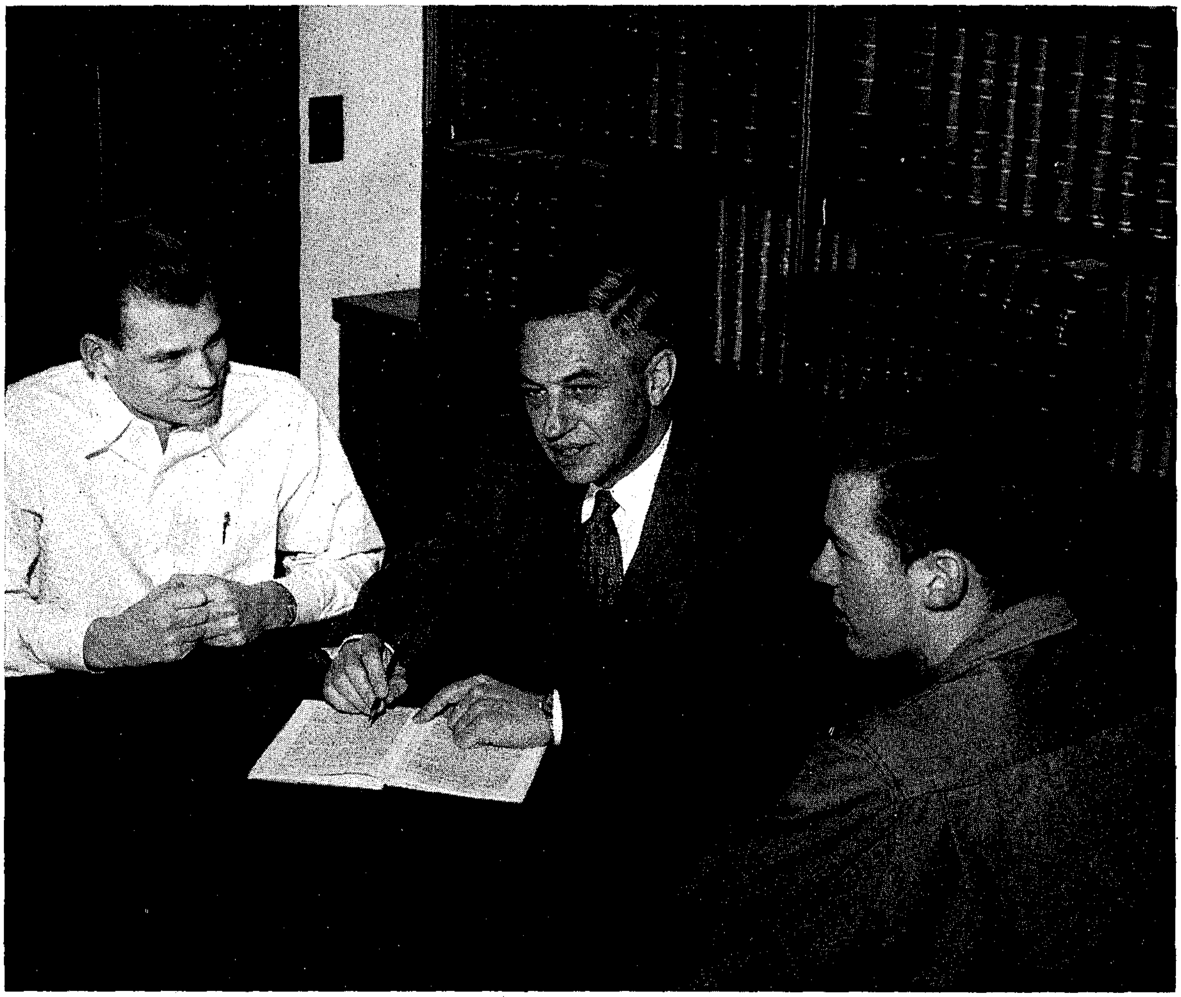
*Reviewed by Hunter Mead*
*Professor of Philosophy and Psychology*

THIS IS WHAT might be called an inevitable book. After arousing such interest with his earlier volume on cybernetics, it was to be expected that Norbert Wiener would follow through with a more popular, less theoretical book on the applications of the new cybernetic science to human affairs. It was also probably inevitable that this book should contain much that has little to do with the theory of communication and control, but instead reveals the wide range of Dr. Wiener's social awareness.

Perhaps a third of the book can be classed as applied cybernetics. Another third can be labeled "the social implications of contemporary technology in general." But the remainder can hardly be called anything more than "Wiener's social and political views."

The general reader will probably find these three sections equally interesting. The author's ability to move with ease from a discussion of the apparent parallel between certain types of feedback phenomena in machines and Parkinson's disease in man, to a comparison between "the Church" and the Communist Party is impressive—and some of Wiener's other jumps are even wider. But unlike many scientists who range outside their field, this one seldom appears naive or dogmatic in his extra-scientific pronouncements. And certainly he is never dull!

This is, in sum, a stimulating and interest-holding book.



# STUDENTS AND THE DRAFT

by L. A. DuBRIDGE

THE "GREAT DEBATE" on U. S. foreign policy is now being paralleled by a great debate on how the U. S. as a nation can most effectively mobilize and utilize its resources of manpower. As dozens of plans and proposals are presented to the public and to the Congress, and as attacks and counter-attacks are waged by scores of interested individuals and groups, the picture appears to be one of hopeless confusion. Is there any chance that reason shall eventually emerge? Is there a chance that as a result of this great debate the nation will arrive at a sensible plan for the effective utilization of our most precious national resource—the nation's men and women?

I have personally participated in this debate through membership on various manpower committees. I have seen at first-hand the complexity of the problems which we face and the confusion inherent in the discussions of them. I am seriously concerned about this problem because of my interest in the future of the students at Caltech and the future of my own son (age 17).

Nevertheless, I can say sincerely that I believe there are grounds for being optimistic.

In a democracy all major national decisions are inevitably and properly arrived at by the means of a public debate. During this debate the picture is bound to be one of apparent confusion. But out of the confusion decisions eventually emerge.

I base my optimism on two grounds:

1. The manpower problem is being taken with deadly seriousness by our government at the very highest levels, with the aid and participation of some of the best informed, most intelligent and most public-spirited citizens of the nation.

2. If one examines the proposals which have been made by the most authoritative government and non-government bodies, one sees a large area of agreement on basic principles. The confusing disagreements are largely on matters of detail.

The difficulties we face in arriving at a proper manpower policy stem from the fact that this nation now faces a problem never before faced in all its history. This problem is that of both creating and also maintaining for a long period a substantial military "force-in-being". In two previous wars we have created a great military force by drafting all available men, keeping them in service "for the duration" and then releasing them all to go home when the emergency had passed. But what do we do when the emergency may be five, ten, or twenty years in duration? In the language of the engineer, how do we arrive at a "steady state solution" of the emergency problem? Clearly in this "steady state" there will need to be a fixed flow of men into the armed services, and a fixed period of service, following which those men will return to civilian life. If substantially every able-bodied boy who reaches the age of 18 (or 19) each year is taken into the service, serves a fixed period of, say, 27 months and is then discharged, it would be possible (taking into account volunteers and career soldiers) to maintain a "permanent" armed force of 3,000,000 to 3,500,000 men. If some men are exempt, the rest must obviously serve longer. This is the idea behind universal military service.

## A normal flow of students

Under such a plan, in the "steady state", the flow of students returning from service into the colleges and into industry and civilian life would be a normal flow, except that each individual would be some two years older. Even under this plan, however, some provision will have to be made for the training of officers, probably through an expanded R.O.T.C. program, and also for the continued education of exceptionally able students who can serve the country better by completing their educational work before entering the nation's service. This type of plan is the one proposed by many scientific and educational organizations and was presented to Congress by General Marshall on January 17.

However, it is the transient period while such a universal military service plan is going into effect which most concerns the present student body. In this area there is the greatest confusion about the detailed mechanisms which should be adopted to insure an adequate flow of men into the armed services, while at the same time insuring an adequate flow of scientific and other specialized personnel through the colleges. But if we once accept the ultimate goal of UMS, the interim problems do not appear difficult.

One proposal which is receiving very serious consideration at the highest level is that if UMS is adopted then *all* members of this year's sophomore and junior classes and all graduate students (especially in engineering and scientific courses) will be allowed to complete their college courses. At the same time, through selective national tests, a substantial fraction (one-half or more) of the country's best freshmen would be similarly deferred and a substantial freshman class would be selected for entrance in the fall of 1951. Since a UMS plan, even if adopted now, would not go into full effect for a year or two, next year's freshman and sophomore classes might actually be nearly up to normal enrollments. Since the selection would be on a national basis, Caltech men should fare pretty well.

There is also under serious consideration a plan to establish a national civilian scientific personnel board which shall be responsible, first, for seeing that trained scientists in the 19-26 year age group are retained in scientific or engineering work, either in military or civilian capacity; and second for insuring a continued flow of students through science and engineering courses, and their proper utilization upon graduation. (Present seniors please note!) Such a board with adequate powers would go far toward preventing waste of precious scientific talent.

What Congress will do with these and other proposals it is too early to predict. The important point, however, is that there is a keen recognition on the part of the highest government officials, including those in the Department of Defense, of the necessity for maintaining a flow of college-trained students, and an even keener realization that the flow of students in science and engineering must be maintained at the highest possible level. It seems to me unlikely that Congress will ignore this clearly recognized problem.

## Advice to Caltech students

What then should a Caltech student do? My advice, based on the present situation, is as follows:

1. Sit tight. The confusion will be over in a few weeks and the future will then be more clear.

2. Do not neglect college work. Do the best possible job in the knowledge that you are thereby increasing your value to the nation and to yourself.

3. Insist on your legal right to a postponement of your induction (if your number is called) until the end of the college year.

4. Do not quit college to get a job or to enlist. At the present time you are better off right here pursuing your work.

5. Do not transfer to an "easier" college or an "easier" course. Your best talents are needed by the nation in science and engineering and there is a good chance that your talents will be effectively utilized. A desperate shortage of such talents is in prospect.

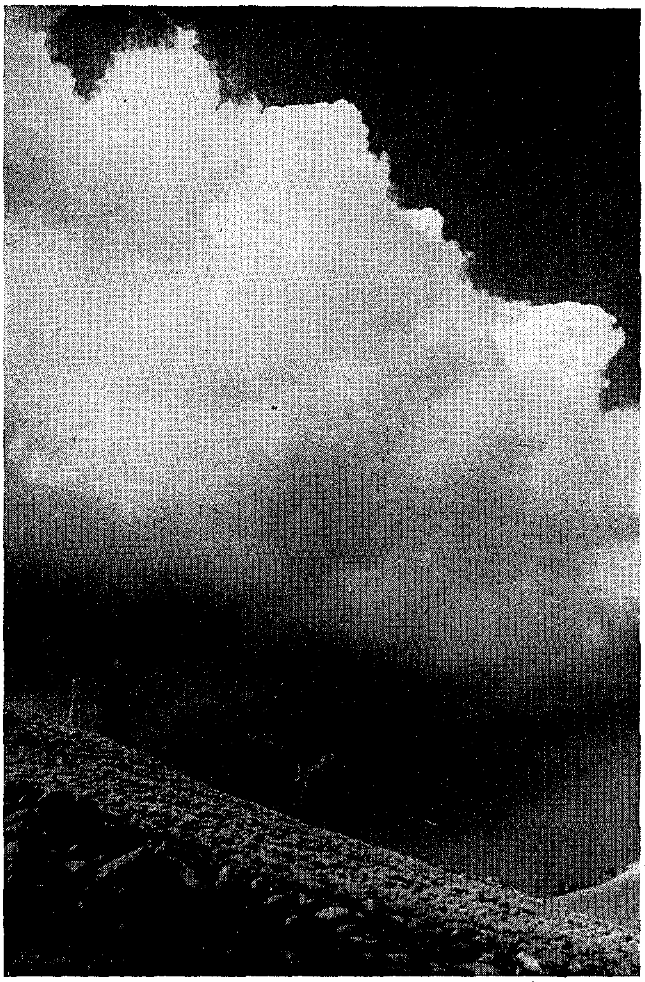
6. Recognize the fact that during coming years every young man should expect to undertake the obligation and privilege of serving his country for approximately two years, in either military or civilian capacity. But recognize also that the chances are now good that scientists and engineers will be assigned to duties which make full use of their talents.

7. Send a copy of this statement home to your parents. It may help them understand your problem.

# CLOUD SEEDING

## A New Technology

by E. BOLLAY, R. D. ELLIOTT and P. B. MacCREADY, JR.



**The artificial nucleation of clouds is already producing rain where and when it is needed. Someday it may even be used to prevent rain, hail and thunderstorm damage**

Scientific discoveries and technological developments in the field of cloud physics during the past four years have opened new and interesting avenues of approach to man's ever increasing endeavor to control nature. Already convincing evidence exists that it is possible for man to increase precipitation very significantly over what would occur naturally by application of cloud seeding techniques, or the artificial nucleation of clouds. This is popularly called "artificial rainmaking." It is based upon the laws governing the formation of precipitation by natural means.

When an air mass is lifted by the large-scale upward motions within winter storms, by small-scale convection within typical summer thunderstorms, or by wind currents blowing normally to mountain barriers, condensation occurs at a level at which the temperature of the lifted air mass approaches the dew point. It must be remembered that the air mass expands adiabatically during its ascent to regions of lower pressure and therefore cools. This cooling is at the rate of about $5\frac{1}{2}°$ F per thousand feet in dry air, and less in moist air.

Unfortunately for those desirous of precipitation, rain does not ordinarily fall as an immediate consequence of the condensation process. Cloud droplets of about 20 microns in diameter are formed upon minute condensation nuclei such as sodium chloride and other salt particles which are nearly always present in the atmosphere. Such cloud droplets have an exceedingly small terminal velocity and therefore can drift almost indefinitely. For precipitation to occur, the droplets must be 10 to 100 times larger in diameter in order to have sufficient mass to fall through the random motions present in air. Collision and coalescence of droplets or additional condensation apparently do not contribute significantly to drop growth at this stage. Since we do know that precipitation occurs, there must be some mechanism to account for it.

There are many theories which attempt to account for precipitation. The most plausible, and the one best explaining the bulk of precipitation phenomena in middle latitude storms, is the Bergeron-Findeisen ice crystal theory which was advanced in the thirties.

*Pioneers in the field of artificial nucleation—Doctors Langmuir, Vonnegut and Schaefer of General Electric.*

It is known that cloud droplets do not freeze upon being lifted to sub-freezing temperatures. Super-cooling is observed at exceedingly low temperatures, even near —40° F. It is also known that the water vapor pressure over an ice crystal is much lower than that over a supercooled cloud droplet. Therefore if a small ice crystal were introduced into a supercooled cloud, water vapor would be transferred to the ice crystal and it would grow rapidly to snowflake size and descend. The ice crystal thus serves as a sublimation nucleus. After falling to lower regions of above-freezing temperature the snowflake would melt and change to a rain drop. In turbulent air the snowflake might be fractured and the various pieces could then serve as nuclei for other supercooled cloud droplets. This is the process which normally takes place within a thunderstorm cloud.

Until recently, not much was known as to where and how ice crystal nuclei were formed in nature. Now we know that they form spontaneously at about —40° F, which is usually at a rather high level in the atmosphere. In many middle latitude storms only a small fraction of the cloud tops exceed the self-nucleating level. Therefore, there exists a large potential of precipitation in the lower clouds, which can be realized if we can find artificial nuclei effective at temperatures between 32° F and —40° F.

Credit is due to Doctors Langmuir, Schaefer, and Vonnegut of the General Electric Laboratories for the basic exploratory work in this new field of artificial nucleation. It was Dr. Schaefer who demonstrated by a simple experiment that supercooled water droplets, which exist in great abundance in natural clouds, can be induced to turn into ice crystals at temperatures of about —40° F. He was able to generate ice crystals which in turn served as nuclei that grew at the expense of the surrounding supercooled water droplets. This method of producing ice crystals is known as seeding with dry ice.

Dr. Schaefer's experiment can be easily reproduced in any deep-freeze unit. A cloud of water droplets is created by blowing one's breath into a box set at about —10° F. The droplets quickly become supercooled. A small pellet of dry ice is then dropped through the cloud. In the path of the pellet a swarm of minute ice crystals becomes visible. They can be seen to scintillate in the beam of a flashlight. The crystals grow at the expense of the surrounding water droplets and slowly descend to the bottom of the box. If they were to fall through a great thickness of supercooled water droplets they would grow to snowflake size.

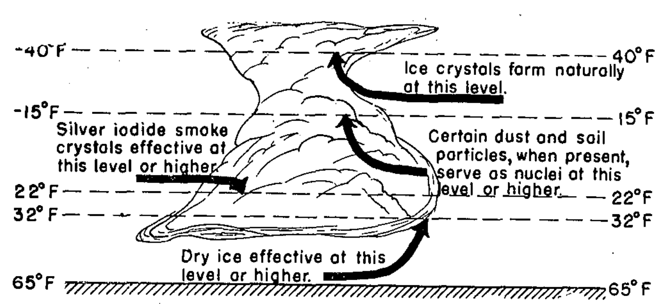
What happens is that the thin layer of air neighboring the dry-ice pellet is chilled to below the critical —40° F level and ice needles form spontaneously. Convection currents mix the trail of ice crystals throughout the box and they thereby nucleate all of the supercooled water droplets present.

Dr. Vonnegut of the General Electric Laboratories later discovered that silver iodide crystals, which are structurally similar to ice crystals, will serve as artificial nuclei at temperatures as high as 23° F. These silver iodide crystals can be easily produced in a silver iodide smoke generator at the rate of $10^{15}$ crystals per minute or per gram of silver iodide burned.

Subsequently it has been found that other substances will serve as nuclei, but not at temperatures as high as 23° F.

## Some recent experiments

What happens when dry-ice or silver iodide smoke crystals are introduced into natural cloud formations? Many experiments have been conducted with varying results during the past four years. The bulk of the work is not described in publications, being held in confidence by the client in the case of work done by private concerns, and probably coming under military classification in the case of some government-sponsored investigations. By far the greatest amount of published




*Different types of seeding processes become effective at different levels in the atmosphere.*

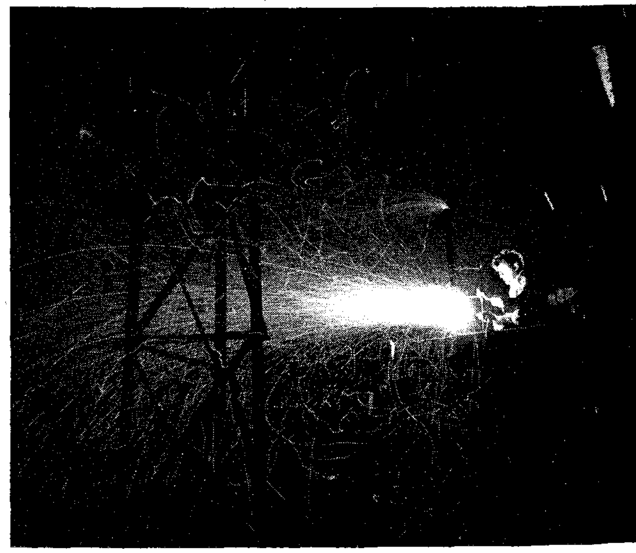
work appears in the General Electric Laboratories' *Project Cirrus* reports. The U. S. Weather Bureau has also published material covering its experiments.

The authors of this article are fortunate in having been in a position to examine data covering several thousand hours of operations by various groups and individuals, the results of which are not generally known. In what follows, the general features of the results of scientifically conducted operations will be outlined.

In order to seed a cloud properly there should be about one nucleus for every thousand water droplets. This permits a thousand-fold increase in drop volume, or a ten-fold increase in diameter, which is adequate to build up small snowflakes. Should there be one nucleus for each droplet, a swarm of small ice needles would form because of the sharing of the water by each crystal. Under these conditions no snowflakes could develop. Clouds treated in this manner would be completely "iced" and probably float away as a cirrus veil. This is what is known as "over-seeding" and it results in a decrease in precipitation, as might be expected.

In an average cloud there are about $10^{16}$ to $10^{17}$ cloud droplets per cubic mile; $10^{13}$ to $10^{14}$ nuclei are then needed per cubic mile to seed it properly. Langmuir has computed that one pea-sized dry-ice pellet will produce $10^{16}$ ice crystals before it is evaporated. Over-seeding therefore obviously occurs in the narrow shaft of the falling pellet. In summer cumulus clouds this concentration of ice crystals will be diffused rapidly by turbulent air motions throughout the cloud, so that a handful of pellets would eventually provide the correct nuclei concentration in an average cloud. A thousand pellets would inevitably produce partial over-seeding, and more dry-ice pellets might result in complete over-seeding. Seeding with dry ice in thin stratiform clouds where turbulent motion is less, or entirely lacking, usually results in over-seeding.

A silver iodide smoke generator produces $10^{15}$ crystals per minute. This is accomplished by first vaporizing the silver iodide at a high temperature, then cooling it rapidly or "quenching" it. Sublimation results in a swarm of smoke crystals about .01 microns in diameter. It is obvious that the direct introduction of this smoke

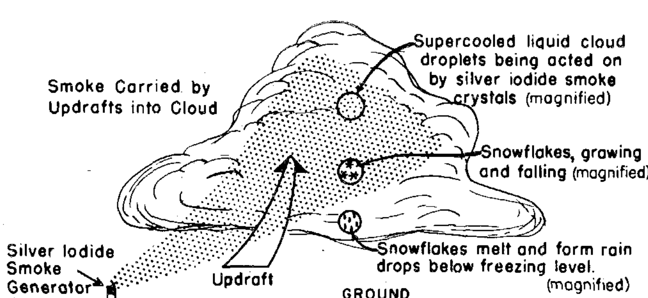


*Dr. Vonnegut uses fire to disperse silver iodide particles into atmosphere at General Electric Research Laboratory.*

into a supercooled cloud from a source producing $10^{15}$ crystals per minute, even if done from a swift airplane, must result in over-seeding as in the case of dry-ice seeding. Again, turbulent diffusion of the ice crystals resulting from the initial nucleation may result in an appropriate mixture of ice and water droplets far downwind where increased precipitation can occur.

It may seem as though the generator output could be reduced sufficiently to avoid this initial over-seeding, but it is easy to show that a million-fold reduction in output would be required.

To avoid over-seeding the smoke must be introduced into the cloud from well beneath the freezing level so that diffusion will result in proper concentrations before the smoke reaches the supercooled portion of the cloud. Fortunately, as first demonstrated by Langmuir, the smoke can be used effectively in nucleating clouds when released from the ground. Under storm conditions currents exist which are capable of carrying the smoke particles from the ground to cloud tops in a matter of hours, or sometimes even minutes. Such currents account for the presence of pollen, dust, sea salt, and other types of small particles which are encountered at all elevations.





*Effective seeding results when silver iodide smoke particles are released from the ground.*

A factor of extreme importance is the release of heat of sublimation as the nucleated water droplets change phase and become ice crystals. If a one-minute supply of smoke from a silver iodide generator nucleated a cloud, then the heat energy equivalent to that of several atomic bombs would be released! Fortunately, this release does not occur in a small volume. Nevertheless, a rise of several degrees in temperature of the general cloud mass must result in a buoyancy force which propels the cloud mass upward with respect to its environment, lifting the cloud top perhaps even to levels where self-nucleation occurs. Simultaneously more moist air is lifted from below to replace that which ascends, and condensation releases even more heat to again increase the buoyancy of the cloud mass. A chain reaction thus develops which can result in a self-propagating storm mechanism perpetuating itself without the aid of further artificial nucleation. It is believed that a development of this type is often triggered by cloud seeding.

The results of experiments with dry ice drops into summer cumulus clouds reflect this release of heat. From Langmuir's experiments it appears that if dry-ice pellets can be shot into just the right part of the cloud, then such a self-propagating storm will develop. If the pellet is injected too high, the top part of the cloud may be over-seeded and become a detached cirrus veil, floating away from the lower cloud mass because of the swifter upper level wind.

## Advantages of silver iodide smoke

In the opinion of the authors, seeding with dry ice has not produced as satisfactory results as seeding with silver iodide smoke. In many cases contradictory results are obtained and much developmental work remains to be done with this technique.

In areas where silver iodide smoke generators have been used the following general results appear: In mountainous terrain, where the smoke is released from windward slopes, appreciable increases in precipitation are noted in an area extending about 40 miles downwind and about 38 miles wide. No effect occurs in the first few miles, as the smoke has not diffused upward into the supercooled clouds in that distance. If the freezing level and cloud ceiling are low, there may be a region of over-seeding in the first 5 or 10 miles. In the center of the seeded area precipitation is apparently often more than doubled.

In flat terrain where the smoke is not aided in its upward diffusion by upslope winds, the area of effect may be at least 10 to 20 miles downwind, and may extend for a distance of 100 or even 200 miles downwind. It will be perhaps 50 miles wide at its widest part. If the generator is located at a below-freezing temperature level (either on the ground or in an airplane) and the clouds are close to the generator, overseeding in the first 10 or 20 miles may quite materially reduce precipitation there.

## Size of the area affected

The actual size and shape of the area is a function of numerous factors, such as the wind direction and force at different levels, the stability or instability of the air mass, and the height of the freezing level. But a rather large area is affected, especially in flat terrain. Therefore, there is no such thing as spotting rain on Farmer Brown's land. The economy of whole regions is involved. In areas of diversified agriculture, conflicts arise with respect to rainfall. In large regions where a single crop is raised, or where cattle ranching is the only industry, the problem is relatively simple. In such a situation, all agree as to when additional moisture will be beneficial.

## Increasing snowpack

Cloud seeding to increase snowpack and subsequent water supplies for irrigation and hydro-electric purposes shows promise as a very beneficial field of application. There is much less danger of conflicting interests because of sparse population in these mountain watersheds. If activities are confined to the higher part of the watersheds, only snow will result. This will melt and run off slowly during the Spring and Summer to be stored in reservoirs. Seeding operations in lower areas, or during exceptionally warm weather, may produce rains and enhance flood danger.

It is well to point out here that there is no evidence of downwind deficiency of precipitation resulting from cloud seeding. There is no significant "robbing" of moisture from those downwind from the operations. Physical reasoning shows why this is so. There is a tremendous amount of moisture passing overhead in liquid, vapor, or solid form. In an area the size of that affected by cloud seeding, only about one percent of the moisture is removed as precipitation by natural process. Seeding might remove another one percent. The air passing downwind would then have a deficiency of one percent, which would soon be eliminated by turbulent diffusion of moisture.

The economic significance of this process is of national importance. The value of rainfall to economic existence, particularly in the western United States, is well known. With this new technology of cloud seeding we are on the threshold of controlling certain weather events on a fairly large scale. Already legislation to control this new technology is being discussed. It is hoped that legislation will not frustrate the development of this frontier of science, but rather serve to coordinate and collect data and license qualified groups to operate in this field.

## Future possibilities

Finally it should be pointed out that the whole matter of cloud seeding to increase precipitation is considered largely in the experimental stage by the meteorological profession. There is no doubt that in the next few years a gradual development of operational techniques will permit a significant increase in the control of precipitation processes. We may see cloud seeding applied to the reduction, as well as to the augmentation, of precipitation. There is also a probability, already supported by a few experimental operations, that the over-seeding principle may be applied toward the prevention of hail by breaking up large cumulus clouds capable of developing hail storms. Thunderstorms might be similarly treated and the damage caused by lightning reduced.

# SCIENCE IN ART

## Raphael's "School of Athens"

by E. C. WATSON

THE "SCHOOL OF ATHENS" is one of the outstanding achievements of that great and versatile artist, Raphael Sanzio (1483-1530). This noble fresco, painted in the years 1510-1511, still adorns one wall of the Papal Signature Room of the Vatican. It depicts with consummate skill an assembly of the great philosophers and men of science of ancient Greece arranged, posed and executed in such a way as to display not only the highest artistic genius but also a very considerable knowledge of the history of philosophy and science.

In the center of the picture stand Plato, the idealist, and Aristotle, the realist, flanked by philosophers of their respective schools, the idealists on the left, the realists on the right. On the lower level, the two corresponding schools of scientific thought are portrayed, on the left the Pythagoreans who believed and taught that pure reason alone can reveal ultimate truth, and on the right the Archimedeans who held that reliable knowledge of the physical universe cannot be attained without observation and experiment. The whole composition symbolizes the essential harmony between philosophy and science, between idealism and realism, between analysis and empiricism, between reason and experiment.

The popular explanations of that great painting that are encountered in travelers' guides and in descriptions of the art treasures of the Vatican are that Raphael

*Enlargement of the lower left hand portion of the painting, showing the Pythagoreans.*

has symbolized in it the course of development of Greek philosophy and that it is possible to assign definite names to all the individual figures. Such explanations go much further than is warranted; nevertheless it is evident that the figure at Plato's right, talking with gestures to the youth in armor, represents Socrates, the man lying on the steps is Diogenes, central figures of the two lower groups are probably Pythagoras (left) and Archimedes (right), and the individual in the lower right-hand corner wearing a crown and carrying a globe in his hand is Ptolemy, for common tradition confused the astronomer with the Egyptian king of the same name.

## The Pythagoreans

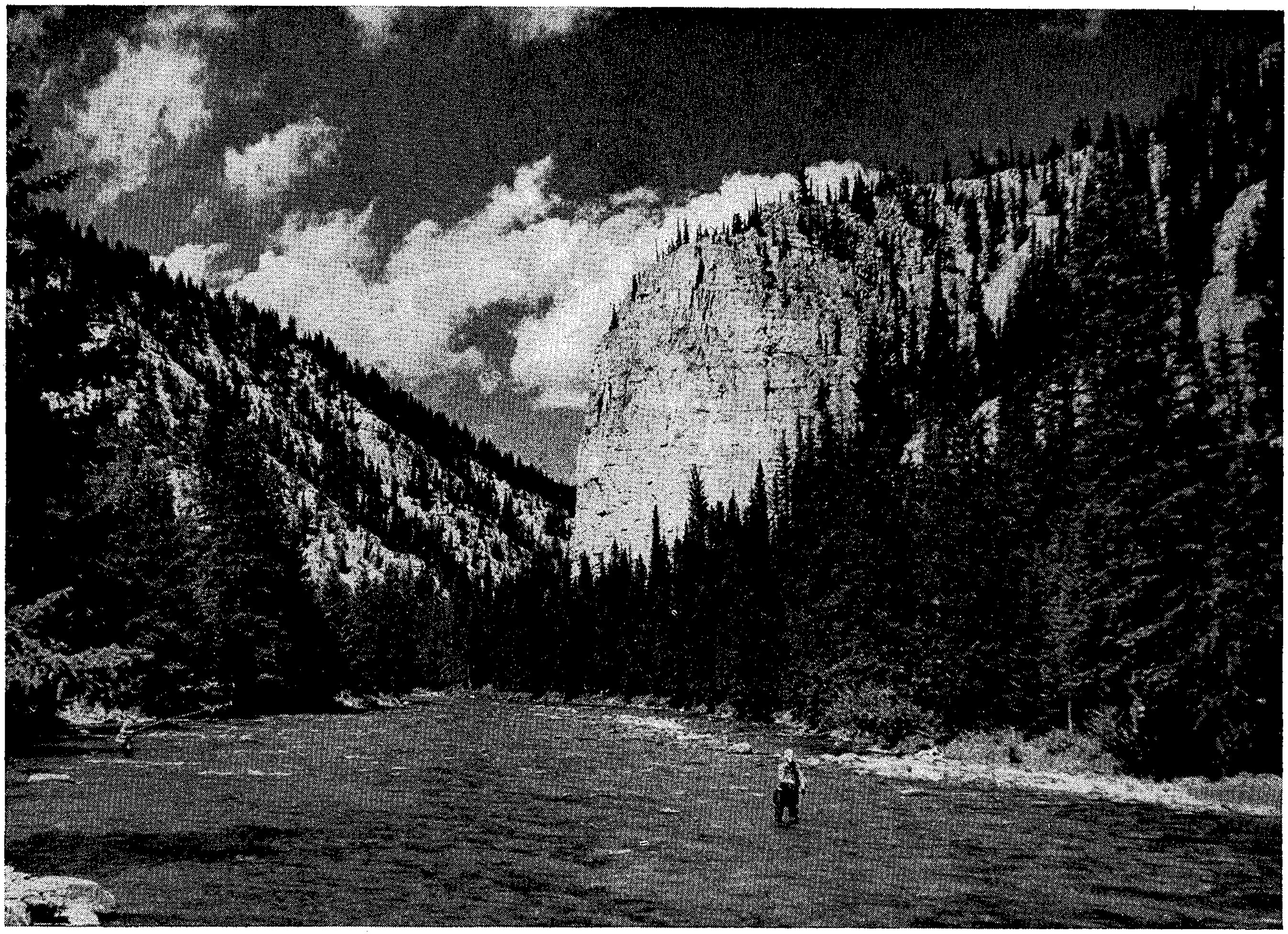
The skill with which Raphael has "clad abstract ideas in forms of life and beauty" is nowhere better displayed than in the group of Pythagoreans at the lower left of the painting. (The picture above is an enlargement of this group). Pythagoras himself is seated and is writing his discoveries about harmony and numbers in a book held on one knee. The oriental figure peering over his shoulder probably symbolizes the effect of the mysticism of the East upon his thinking. The boy holding before his master the number diagrams that he has drawn upon a board may well symbolize the hope that the seemingly "infinite complexity of nature is really as simple as a child's arithmetic." That Pythagorean science was broad, human and universal in its appeal is made clear by the various ages, sexes and nationalities represented in the group. The solitary individual seated at the right probably does not belong to the group proper and is usually identified as Democritus because he is booted in the manner of his countrymen, the Abderites.

## The Archimedeans

The spirit and procedures that characterize teaching and learning at their best are beautifully depicted throughout the picture and give it its modern name, the "School of Athens." Thus, in the group at the lower right-hand corner of the painting (shown enlarged below), Archimedes bends down and draws geometric diagrams on a blackboard. Four pupils surround him and listen attentively to his demonstration. In them Raphael has pictured with unexcelled skill the degrees of understanding and the process of gradual mastery of the subject matter. One boy kneels on the earth and follows with close attention the hand of the teacher; he imitates the master's motions, but he does not understand. Leaning over him, stands another boy; his face, as well as the motions of his hands, indicates that he understands what he sees. A third boy with uplifted face, having mastered the demonstration, imparts it to the fourth boy. And the face of the fourth reflects the joy of achievement and complete understanding; he is able to conceive of the far-reaching consequences of the theorem that has been proved.

*Enlargement of the lower right hand portion of the painting, showing the Archimedeans.*

*One of a series of articles devoted to reproductions of prints, drawings and paintings of interest in the history of science—drawn from the famous collection of E. C. Watson, Professor of Physics and Dean of the Faculty of the California Institute.*



# THE SCIENTIFIC FISHERMAN

by WILLIAM W. MICHAEL

THE LEGENDARY COUNTRY BOY with the bent pin and the willow pole, which he cut from a bush along the creek that flows through his farm, showing up the city sportsman with his expensive tackle on the hard-fished streams of America has long ceased to exist. In fact, this small boy probably never did have much success. He served and still does serve a useful purpose in the comic strips and on some of the calendar pictures.

The man who has studied his subject or hobby and worked over every phase of it is the man in whom you will place your faith; not the small boy who knows practically nothing of the habits of trout.

This man has in his leisure moments studied the dry-fly techniques from every angle. He has devoted much time to close observation of all the factors which contribute to success. You hear him talk about insect life—the different species of insects, the time of year they are in evidence, their life cycle, and their artificial imitations. He has studied the streams, and although he may not be an expert hydraulic engineer, he knows stream currents and velocities. He can tell by looking at the stream surface just where there may be a probable lie for a good fish.

His friends may think that all he knows about optics is limited to what he sees through his bifocals; they may be surprised to learn he has made a careful study of what the trout sees of our world of air and sunshine from its underwater domain. From his knowledge of optics, this man knows just how to approach a feeding fish so he will not be visible to his quarry.

His knowledge of chemistry may be limited to the fact that baking soda may neutralize his acid stomach induced by an overindulgence in hotcakes and syrup before he took to the stream that morning. However, he will carry a stream thermometer, and when the temperature rises beyond a certain point, he knows the oxygen content of the water will be less and probably the fish will be found near the cold-spring runs.

When it comes to psychology, he undoubtedly will admit that all dry-fly purists, including himself, need

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the attention of a psychiatrist, but he is too busy with his sport ever to consult one. His mental attitude will play an important part in his success.

All these factors, together with many others, may readily be classed under the heading of the part played by the sciences. Let us take them one by one and look into their relation and application to dry-fly fishing.

## Entomology

One who has never had the cycle of life of the common stream insect brought to his attention has missed one of the most interesting things in trout fishing. Briefly, it is about as follows: In its initial state an insect is a larva. Grubs and caterpillars, for instance, are larvae. From the larva stage, the insect passes into the pupa and last to the imago, or fully developed insect. A pupa may be likened to the caterpillar and the imago to the butterfly. In so far as it affects the trout fisherman, the metamorphosis is as follows: The female fly deposits its egg on or in the water of the stream; in turn the egg sinks to the bottom and hatches into the larva, which in the pupa stage may or may not incase itself in a covering attached to a stone, log or twig on the stream bottom. In the course of time, usually anywhere from one to three years, certain physical changes take place, until finally the insect is ready to dispense with its covering, rise to the surface, and take to the air. The imitation of this rising nymph from the stream bottom is the common, artificial wet fly.

After the natural nymph reaches the surface, its wings unfold, and it flies away, a fully developed insect. Before flying from the water, it often rides along on the surface while the wings are drying and developing. It is at this stage that the trout fisherman imitates the natural with his floating dry fly. This word "imitates" sounds exceedingly simple, but so many things actually come into account that effective imitation is the most difficult thing the dry-fly fisherman has to contend with.

When this phenomenon is taking place—when new life is being born, the nymphs are rising to the surface, and the fully developed insect is floating on the water—the fisherman speaks of a "hatch." It is his greatest wish, when he is on the stream, that a hatch may develop. Naturally, this is the time that the trout are on the prowl for food. If he can imitate this hatch and simulate its performance, then his chances of good fishing are at a peak.

I have stood beside the pool of one of my favorite streams in the Catskills of New York of an evening and have seen literally hundreds of insects emerging from the surface of the water. So many have been in the air at a time that it was possible to catch some of them in one's hand; one could examine the sample and frantically search through his fly box in hopes of finding a correct imitation of a natural.

We find that on the Eastern streams the "May-fly" season is at its height somewhere from the middle of May until the middle of June. No definite time can be set, however, for this peak. Much depends on seasonal conditions. If given one month to fish the streams of the Catskills, I would, on the average, choose from May fifteenth to June fifteenth. If given my choice of time for my favorite Rocky Mountain streams, I would probably select from the middle of August to the middle of September. This is not necessarily due to the fact that in the Rockies the biggest and best hatch takes place at this time but more to the fact that by the middle of August the water has dropped to a low level, and the fish appear to be hungrier for a surface food than early in the season. With a dry fly in this region, I have found, after years of experience, that the longer I stayed, the better the dry-fly fishing became. Unfortunately, I was never able to stay long enough to see what might happen after the tenth of September. I had not yet reached the point, if ever I will, of economic security whereby I could fish as long as I desired. I still have to work in order to eat in order to go fishing.

To the American fly fisherman there are probably some four different kinds of natural insects which are of special interest.

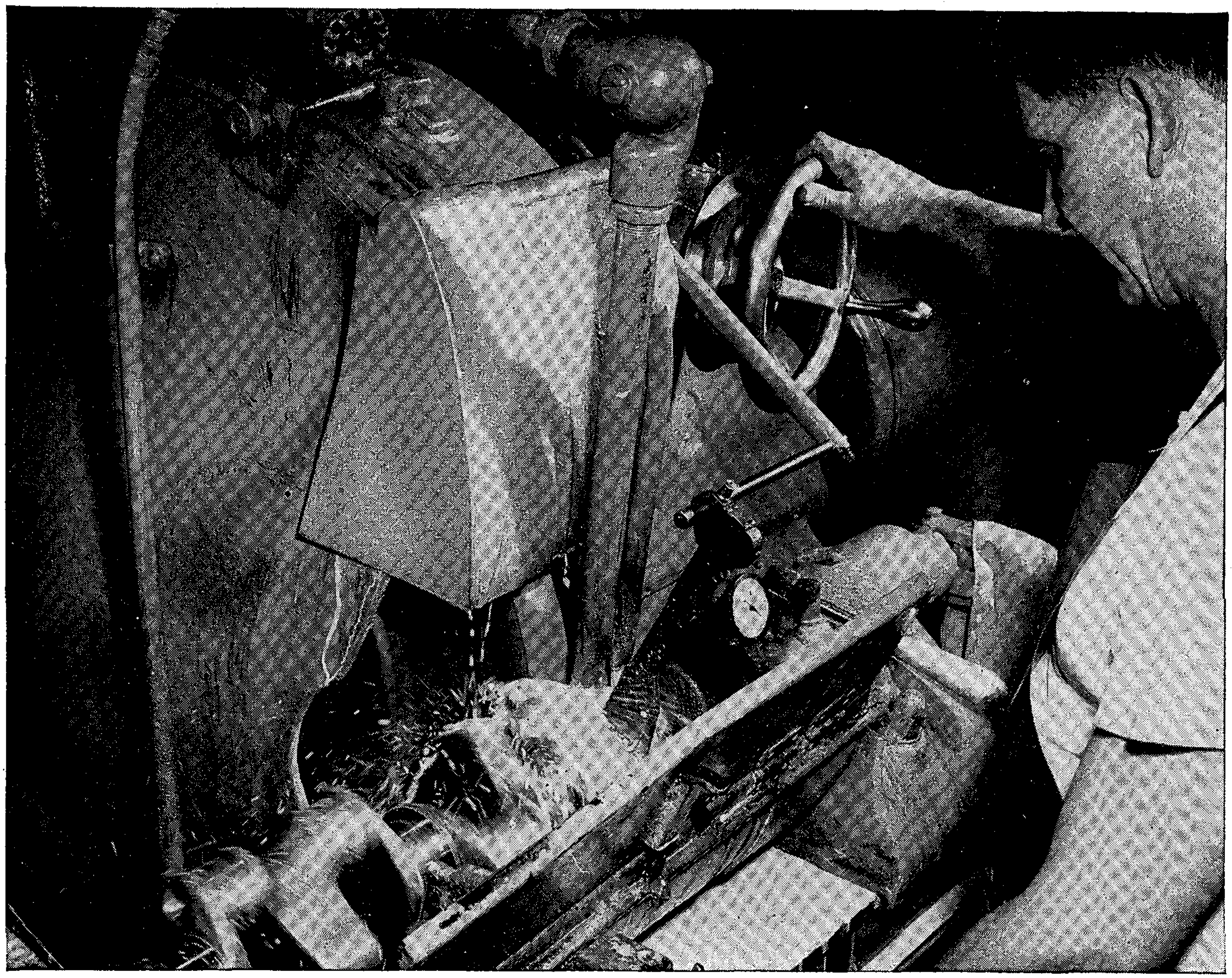
1. Neuroptera (nerve-winged insects)
2. Hymenoptera (insects which have a wasp waist)
3. Coleoptera (beetles)
4. Diptera (two-winged flies)

Taking the Neuroptera, we may subdivide them as far as the angler is concerned into Ephemeridae, which include the May flies, the duns, and the like; Perlidae, which are the stone flies; Trichoptera, which include all the caddis flies; and Chrysopidae, the so-called lacewings and the Sialidae or alder fly.

Ephemeridae are most plentiful on the Eastern streams during May and early June. They can be recognized by

CONTINUED ON PAGE 18

*Bill Michael ties a dry fly*



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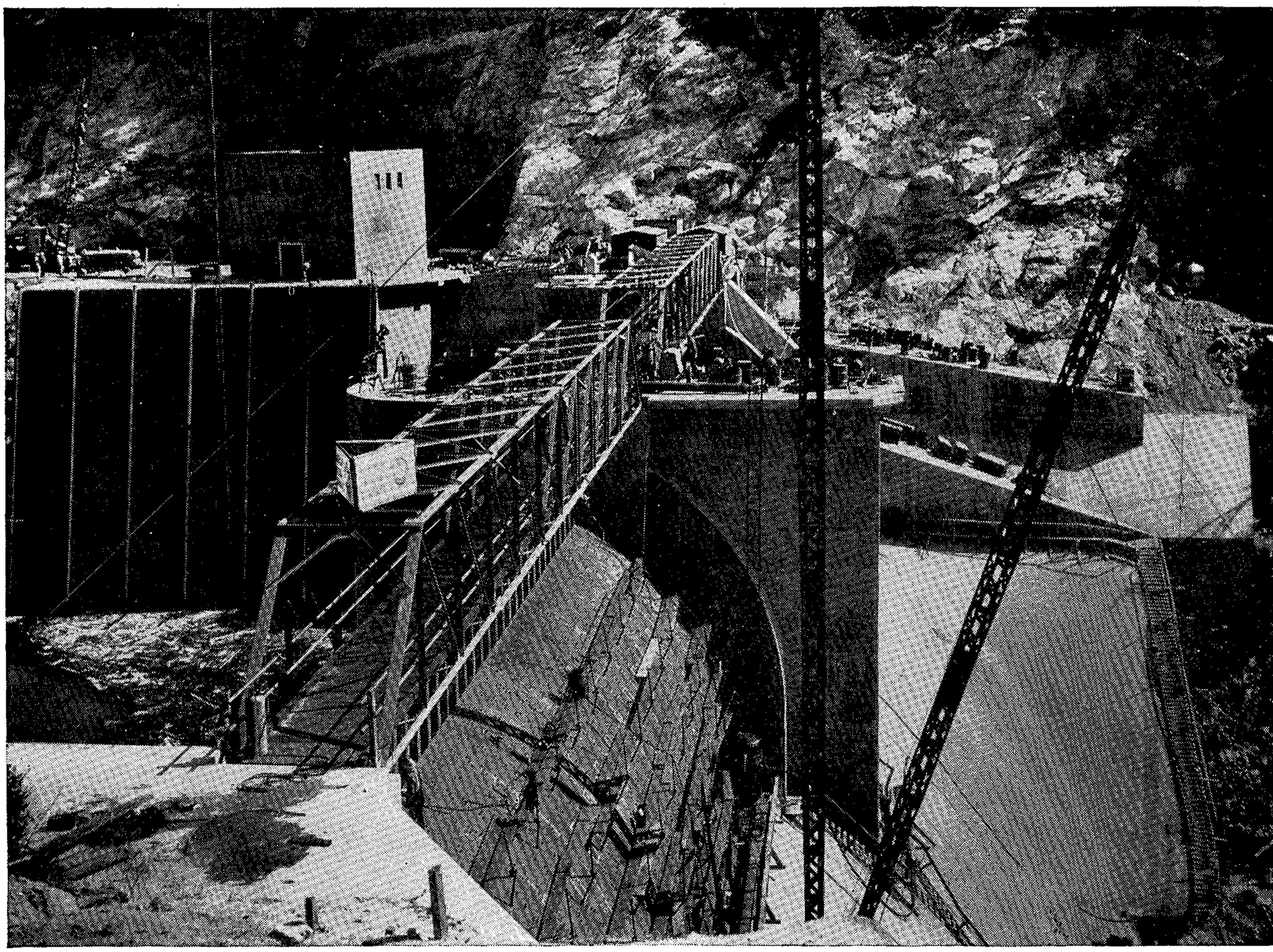

**ACTION IN CALIFORNIA.** On the north fork of the Feather River in California, Pacific Gas and Electric Company has placed two new dams . . . Cresta Dam and Rock Creek Dam. The huge drum gates for these dams, and the bridges directly above them, required 4,380,000 pounds of steel. They were fabricated and erected by United States Steel.

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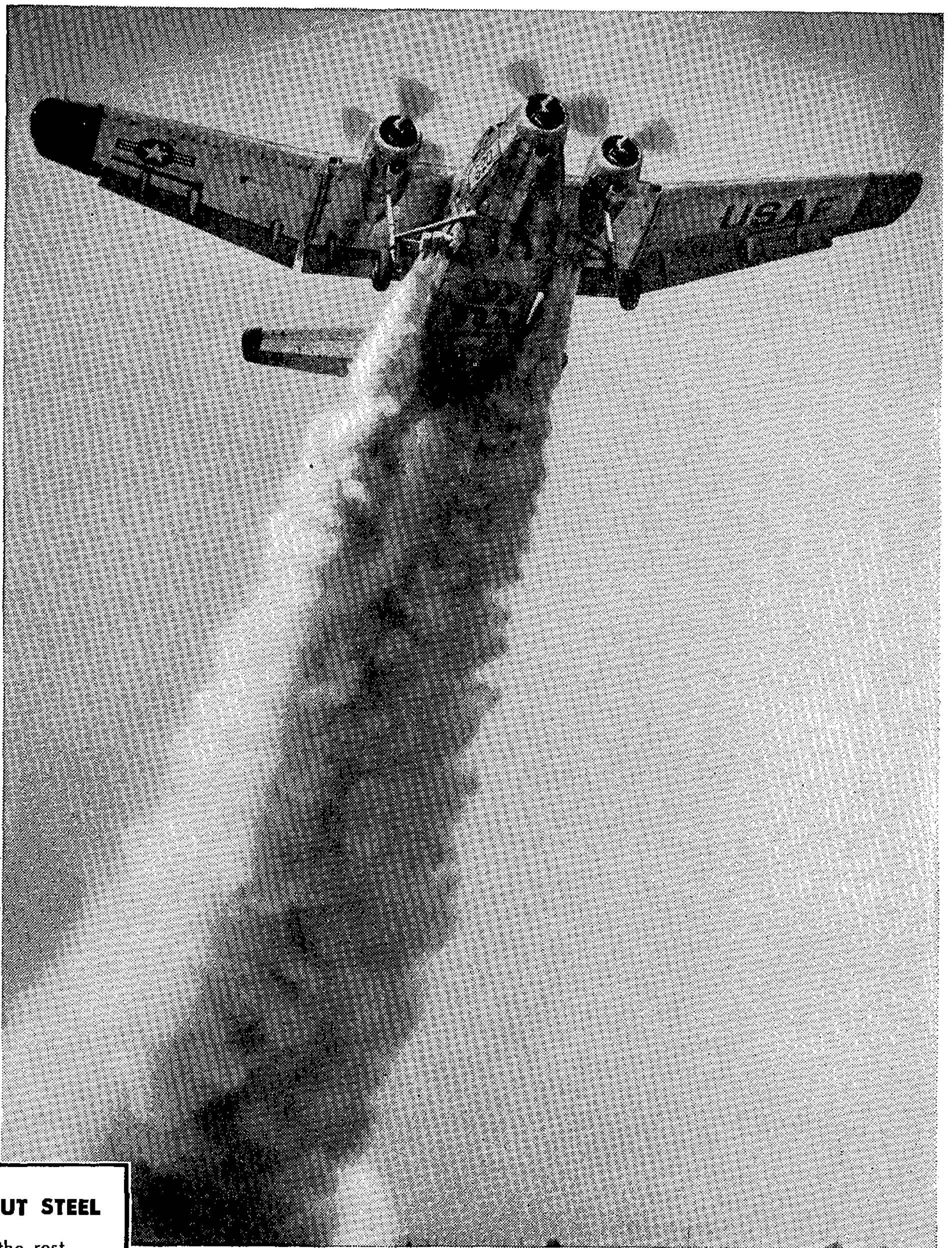


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their upright wings and long tails. Often they may be observed floating downstream by the hundreds with their wings erect, glistening in the sunlight.

The Perlidae, a subdivision of the family of Neuroptera, are the so-called stone flies which have their habitat in the larval stage on the stony bottom of the stream.

The Trichoptera are the familiar caddis flies. Every fisherman, be he wet or dry, is familiar with the caddis cases found clinging to submerged sticks or to the rocks on the bottom of the stream. Often the bait fisherman will extract the larva from these cases and use it for bait. In cleaning trout one often finds their stomachs full of these caddis cases, a favorite food. The eggs are laid in the water in a gelatinous state, and when the larvae emerge, they incase themselves with any material available, which they cement together to form the "caddis case."

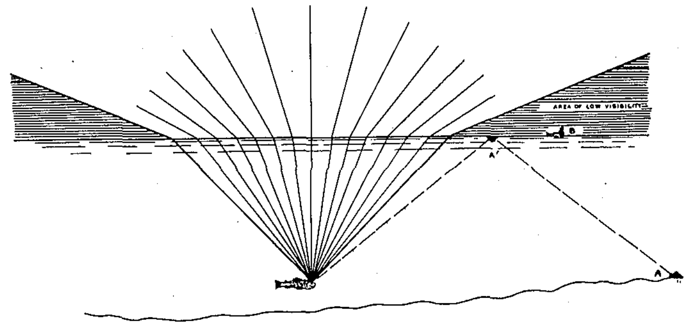
The Hymenoptera are not aquatic insects but at times, through accidental or other causes, do get on the water. They include all the wasp-waisted insects, such as ants, bees, yellow jackets, wasps, and the like.

The Coleoptera, or beetles, are not of interest so much to the dry-fly man as they might be to the wet-fly or bait fisherman.

The Diptera flies, so named because of their two wings, are usually and most commonly used by the dry-fly man in a form tied small as a gnat, the Black Gnat and Green Gnat being typical examples.

## Optics

In order to get the trout's point of view, one must mentally project himself into the trout's environment underwater. This introduces a study of optics. A trout usually points upstream into the current, and for that reason the dry-fly fisherman approaching from downstream has the distinct advantage. What the fish sees of our world is limited to what is commonly known as his "window." It is as though the underside of the surface of the water were a mirror with all the stones and other objects on the stream bottom reflected against it, except directly overhead, where there is a circular area through which the trout looks into our world. This can be seen more clearly in the drawing above. The fish's vision is restricted to reflected rays from objects outside the water. A ray of light coming from directly overhead will go directly to the fish. Any ray coming from any other point except directly overhead will be refracted, the angle to the horizontal becoming flatter as the edge of the window is approached. Remember that this window is circular and can be compared to a funnel with the small end at the fish's eye. Finally, we reach a point, shown by the very heavy line in the drawing, where only a small portion of the rays will penetrate the water. Most of them will be reflected up,



THE TROUT'S WINDOW

so that anything will be less visible to the fish in the shaded area than in the nonshaded area.

The first time I ever was aware of being able to approach closer to a trout in shallow water than in a deep pool was many years ago on a tributary to the famous Esopus in the Catskills of New York.

I had been using a No. 14 Light Cahill fly and had been concentrating my efforts on the deeper runs. I had not been too successful and had attributed the fact to the time of day. It was around two o'clock in the afternoon, not the most propitious time of day for a dry fly. However, with the sun at my back, my shadow must have fallen on the water, and at my advance I observed many fish dart away out of the deeper runs.

As I waded upstream through the ankle and knee-deep water, I saw several fish wait until I was a few feet from them before they would dart away to seek shelter from me. Here, for the first time, I started to analyze the situation. Why could I approach so near to these trout, often seeing them before they saw me? Without trying to get the answer, I immediately changed my tactics and started to reverse my procedure by fishing the shallows and passing up the deeper runs. I started to take fish on what were relatively short casts. That evening I took out pencil and paper and went to work. By the aid of a sketch of the trout's window and the area of vision he covers, it was not long before I had the simple and logical answer to the problem; viz., the nearer the surface the trout may be, the more restricted is his vision. His window area is in proportion to his depth.

In line with this same reasoning, it is my opinion and my experience that the most difficult places to interest a trout with a dry fly on any stream are the deep pools. Not only is the fish's vision area much larger, but also he more often than not is down in the depths of a pool, and the effort to come up through many feet of water to take a surface fly appears to be a useless undertaking. Once in a while he will do this, often at the lower end of the pool where it may shallow off before the water spills out over the downstream end. When he is in this part of the pool, he has purposely taken up a feeding position in the shallower portion of the pool in order to command a better view of the approaching food. Once he returns to the depths, it is extremely difficult to interest him in anything except bottom food. It does not pay to spend too much time

CONTINUED ON PAGE 20


THEY'RE both good basketball players. But if we were to judge them the way we judge telephone equipment, we'd take the small one.

You see, telephone equipment occupies valuable space, uses costly materials. Paring down its size helps keep down the cost of telephone service.

Take voice amplifiers, for example. Telephone engineers put the squeeze on size, came up with a new small type. When 600 of these new amplifiers are mounted on a frame two feet wide and eleven feet high, they do a job which once required a roomful of equipment. Size was cut—but not performance!

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**BELL TELEPHONE SYSTEM**

casting over the very deep water. I must admit, however, that these are the very intriguing portions of any stream, and the chances of a big trout in these waters is excellent. We all try them, I know, for the attraction of the big ones is difficult to resist.

The often repeated warning not to let your shadow fall on the water is excellent advice. However, the fish does not have an eyelid and cannot close his eye as a human being does; consequently, when the sun is shining on the eye which is on the side of the sun, it is more or less blinded. This gives the fisherman a distinct advantage if he approaches the fish between the sun and the fish rather than on the shaded side. By casting the fly on the far, or shaded, side, he causes the trout to see it with his eye away from the sun.

Another point to remember is to keep as low as possible, trying to blend in with the foliage, if there is any. Also, one's clothing should be of a subdued color. Avoid wearing anything white, remembering that reflected light from a white object will carry to the trout almost as readily as though a mirror were reflecting the light. And don't forget that a rod held high is more visible than one held low with the cast being made from the side.

It is questionable whether or not the sight of a fish is as important as his reactions to vibration. There is a so-called lateral line running along the fish's side marking a highly sensitized nerve. It is this lateral line that warns him of approaching enemies by the vibrations set up in the water. For this reason, extreme care should be taken when wading and walking along the banks, particularly if they are undercut as we find them in some of the meadow streams. Authorities have stated that the ear of the trout is rudimentary; its chief function is to maintain a sense of equilibrium.

## Chemistry

Chemistry enters into our fishing to a slight extent. We know that a range of water temperature from 50 to 65 degrees Fahrenheit is the most ideal range for dry-fly fishing. When the water reaches 74 degrees, it is almost impossible to interest a fish in any artificial fly. The oxygen content of water is proportional to its temperature. As the temperature rises, the oxygen content diminishes, and the activity of the fish also diminishes. It is for this reason that the expert will carry a stream thermometer to determine whether or not the maximum temperature has been exceeded. If at all possible, he will seek those places where spring runs enter the stream or where the more aerated water is.

## Meteorology

The subject of meteorology has definitely some bearing on trout fishing. It is known that the barometric pressure influences the results to a marked extent. On a falling barometer the fisherman may as well stay at home as far as any fly fishing is concerned. Once the barometer reaches its lowest point, it may linger there until the storm center has passed, and his chances may slightly improve. Once, however, the barometer starts up or is in a high position, the prospects are excellent. We do not know why an approaching storm affects fishing, but I have seen this condition hold in almost every instance.

## Psychology

What would we see if we were trout? What would we eat? Where would we be? After fishing for years on many streams, one finds that the answers to these "trout-world" questions become a matter of simple logic. It has best been spoken of as "fish sense." It can be gained only by experience, constant observation, and perseverance.

Probably we are prone to credit a trout with much more sense or intelligence than that with which he is actually endowed. After all, the brain of a 14-inch trout occupies a space about the size of a pea. His nervous system is not too highly developed. It must be fear and fright rather than pain that cause him to fight the tension applied to his tackle by the fisherman. You may readily prove this fact if sometime you will deliberately ease off on the battling trout once you have hooked him. More often than not he will cease his struggles and either slowly swim away or remain stationary in the water until you again stir him up by applying tension.

Trout are on the search for food all the time unless their feeding is interrupted by the approach of some potential enemy. The great bulk of their food supply comes from under the water and not from the surface. Much of it is obtained from under the stones on the bottom, from caddis cases attached to sticks and stones, from food washed into the stream when a storm causes a runoff from the adjacent banks. Relatively a very small per cent of their sustenance is derived from the surface feed. No one seems ever to have explained the psychology of a trout's fondness for the very small tidbit he gets from a floating fly. One writer has mentioned that probably a surface-feeding trout expends more energy and burns up more fuel to rise to the surface in order to take a floating fly than is replaced by the nutritive value of the fly itself. It is possible that if a fish fed exclusively on the surface he might, according to this supposition, eventually starve to death!

The intriguing thing about this dry-fly game is the absolute uncertainty of it. You most likely will have several days in a row that have been so successful you come to the conclusion you have the game licked, and from now on it is going to be an easy matter to take as many fish as you want. All at once comes a day when try as you may the fish will not cooperate at all with you! When this occurs, are we put in our place? Decidedly so! Maybe there is more than fish psychology in this performance on the part of a cold-blooded animal with such a small brain. After all, what a fool it can make of a man!

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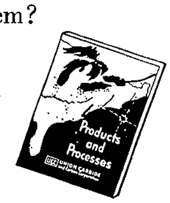


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# THE MONTH AT CALTECH

## Public Affairs Room

CALTECH STUDENTS have a new tie with the outside world in the Public Affairs Room now set up in Dabney Hall. The room is operating under a grant from the Carnegie Corporation—which has given the Institute $150,000 to be used during the next five years to improve undergraduate instruction in the humanities and social sciences.

The Public Affairs Room is stocked with newspapers, news magazines, journals of opinion and government bulletins from all over the world—a cross-section of the press of this and other nations. Its purpose: to make available to Institute students and faculty all the best sources of world news and current events, reflecting both liberal and conservative opinion.

The Room receives the daily air-mail editions of the New York *Times* and *Herald Tribune*, the St. Louis *Post-Dispatch*, and the San Francisco *Chronicle* as well as the local Los Angeles *Times* and the *Examiner*. There are magazines like *Time*, *Newsweek*, the *United States News*, *The Reporter*, and publications of the State Department, the Pan American Union, the National Committee for Free Europe, the Friends Service Committee and the Citizens Committee for the Hoover Report.

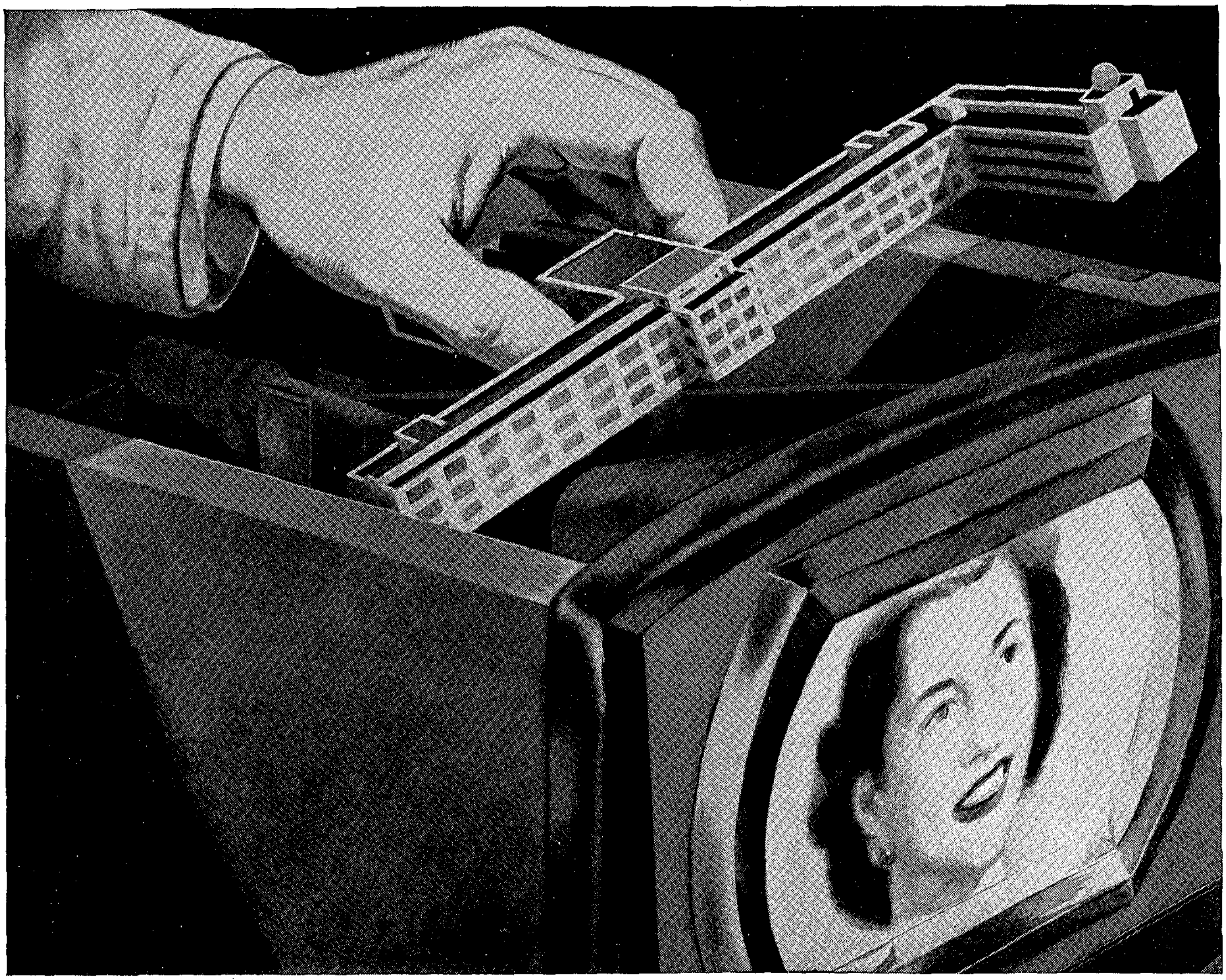
From England come the weekly air-mail editions of the London *Times* and the Manchester *Guardian*, as well as magazines like *The New Statesman and the Nation, The Economist, The Spectator and The Listener.*

Other foreign publications come from such diverse sources as China, France, Germany, Indonesia, Israel, Norway, Pakistan, Poland, South Africa, Soviet Russia and Turkey—most of the material written in English.

Besides newspapers and magazines the Room contains a selection of recent books which tie in with current events. A series of changing exhibits and wall displays are intended to clarify some of the issues underlying the news.

The Public Affairs Room has a progenitor at Dartmouth College, where a similar room has been set up since 1947 as part of a Great Issues Course required of all seniors. But the Public Affairs Room is a revolutionary and valuable addition to the intellectual life of a scientific institution. At the very least—and on very short exposure—it provides a lesson on how to read. By offering several viewpoints on the same current events it can prove to a student that he can judge what he reads only as long as he knows where he's reading it, and why it was written. At the most, of course, it provides an opportunity for the student scientist or engineer to learn more about the world outside his classroom or laboratory—and possibly even something about the place he can take in that larger world.


*Mrs. Doris Logan, in charge of the Public Affairs Room, keeps on top of the news, advises students on reading.*



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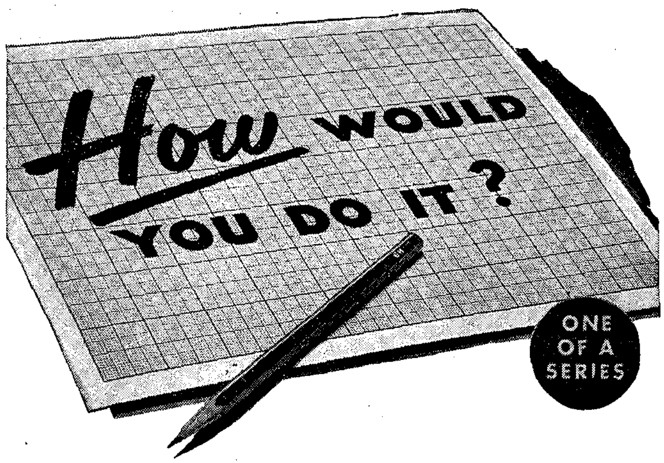


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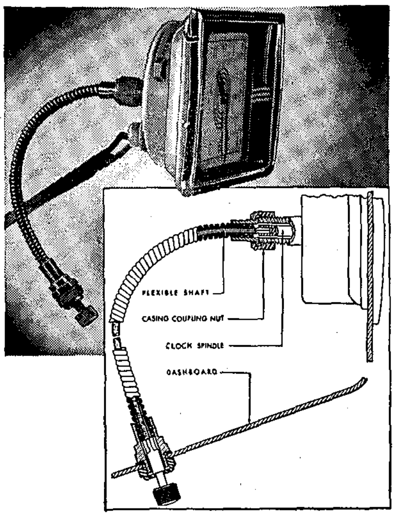


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# THE BEAVER

## Some Notes on Student Life

THE BEAVER GAZED at his calendar, which listed the season's coming social events, and sat back to puff meditatively on a scored pipe. There was certainly no lack of these events; there were dances, sports events and all the other entertainment which seemed so important at all other times of the year. But the Beaver was uninspired, and unimpressed.

He considered the matter and concluded that it was not a lack of social life that made the second term different from the others; it was the frame of mind of the student body. It appeared to him that a universal boredom had settled in.

The Beaver observed further, however, that the students had found multiple and varied ways to overcome this ennui. These tricks were not always new; most of them, in fact, were revived at least every four years.

Just a few nights ago, for instance, one of the frosh had been astounded to hear groans, catcalls, obscenities and the clanking of many chains issue from the walls themselves. Being a frosh, he was unacquainted with the unique architecture of the student houses, which provides an airspace between the rooms and thus allows speakers, driven by tremendous amplifiers, to be lowered for the sole purpose of making the frosh quake with alarm.

The frosh were quick to retaliate. A group of prodigal engineers somehow located the proverbial cement mixer and, by judicious maneuvering, managed to stow it in the room of some ever-wise sophomores. The contrivance was provided with fuel, as well as the proper ingredients, and set going.

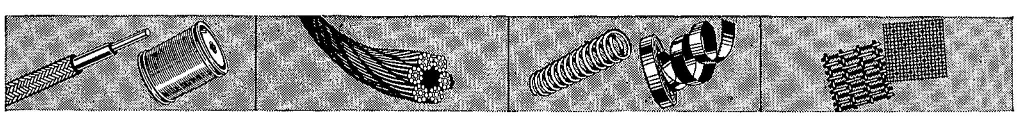
The sophs, refusing to be outdone, found most remarkable uses for the cement which the frosh had so considerately supplied. The Beaver wagged his head in amazement at their endless activity.

In the past there had been even more imaginative schemes—such as that of the lover of chemistry who, donning a chef's outfit complete with fantastic hat, had entered the laboratory where qualitative analysis was in its usual state of confusion. The chef proceeded to place a bouillon cube in each of the unknowns. The instructor, agog, inquired of the student's sanity—only to find that the young chemist aspired to be the true "cook book chemist".

But the Beaver's reverie was broken by a ruckus of epic proportions in his usually quiet alley. The boys were at it again. He opened the door and beheld an array of newspaper-laden scholars converging on the room of an unfortunate engineer who had gone home for the week-end. The newspapers were properly conditioned and, after the room was filled to the brink,

CONTINUED ON PAGE 26

THIS PICTURE STORY had whiskers when John A. Roebling built the Brooklyn Bridge, 85 years ago. • But the warning it sounds is as current and as urgent as it ever was in the history of our country. • No mule ever will get much of a meal by pursuing hay that is kept out of his reach by a stout pole. • No nation whose rising wage scale keeps prices spiraling upward ever will attain true prosperity. • No nation has yet found the secret of making products at prices that do not depend upon wages. • If we expect to stop the inflation spiral we're in, we will have to contribute more, individually, instead of merely collecting more, individually. • And let us not lose sight of this objective during periods of government controls that are temporarily forced upon us by national emergencies. Let us keep our eye on the long range picture. Let us remember that we can have more only if we give more...that we can not really increase our income, unless we also increase our productivity. • Inflation wages can no more catch up with inflation prices than our mule can catch up with that elusive hay. John A. Roebling's Sons Co., Trenton 2, New Jersey.



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ROEBLING

# THE BEAVER . . . CONTINUED

the last few remaining scraps of paper were forced through the transom. It was a rare sight to behold the unfortunate engineer, equipped with a flashlight, burrowing like a mole for twenty minutes, as he sought frantically for books for his approaching class.

Well, these were some of the methods of curing the second term blues. They proved pretty effective too.

## Making money

The opportunity to earn money does not occur too often on the campus, so it was with considerable haste that the Beaver went to sign up for the Mobilgas Economy Run. Alas, he was too late. Some forty fortunate students, both grad and undergrad, had managed to beat him out. This Economy Run is a test conducted under the auspices of the Automobile Association of America to determine the performance and gas consumption of stock autos manufactured in the United States. The Run takes place over a 700-mile course which offers considerable variation in temperature, altitude and roads. The Techmen recruited for the Run will serve as observers in this annual event.

The Beaver was pleased to learn that men from Tech were chosen for these jobs because of our honor system. Apparently, in previous years, there have been occasional discrepancies in the data obtained on the Run. It was certainly nice to realize that such things as the honor system were known to the outside world.

The seniors were finding the interview season painless this year. A small group of job-hunters could always be seen in the Placement Office, seeking information or reading the stacks of literature which the companies publish about themselves.

Jobs are going to be easier to get this year—at least for those who will be around. And the seniors have been told that they will have a choice of jobs. The Beaver pondered the words of the interviewer and remembered how, only a few years ago, situations were very difficult to find. He mused on the changing world and thought how good it was for a man to be able to pick his job.

## Tough term

The Beaver gazed out into the downpour which had begun and wondered who would ever consider offering him a position of worth. A sudden yen seized him and he bounded toward the door. As he tugged at the knob, the door fell from its hinges and a collection of water-filled pots crashed about his ears. Stunned, he surveyed the wreckage. Yes, the second term could kill a man.

—*Bob Madden '51*

# ALUMNI NEWS

## Seminar Speaker

HORACE GILBERT, Professor of Economics, will be the principal speaker at the Alumni Seminar dinner on April 14th. His subject: "Conditions in Germany Under Russian Influence."

Prof. Gilbert, who has been on leave of absence since the fall of 1949, serving on the staff of the U. S. High Commissioner of Germany, will return from Frankfurt to resume his teaching duties at the Institute at the start of the third term on April 1.

## Ward Foster

WARD FOSTER '27 is recuperating from an emergency cerebral operation performed early in December, after a sudden attack while at his office in Los Angeles. He is now at home after six weeks in the hospital and appears to be making progress toward a complete recovery. Short encouraging notes addressed to 4905 Lockhaven Avenue, Los Angeles 41, are in order, but visiting is discouraged except for a few intimate friends.

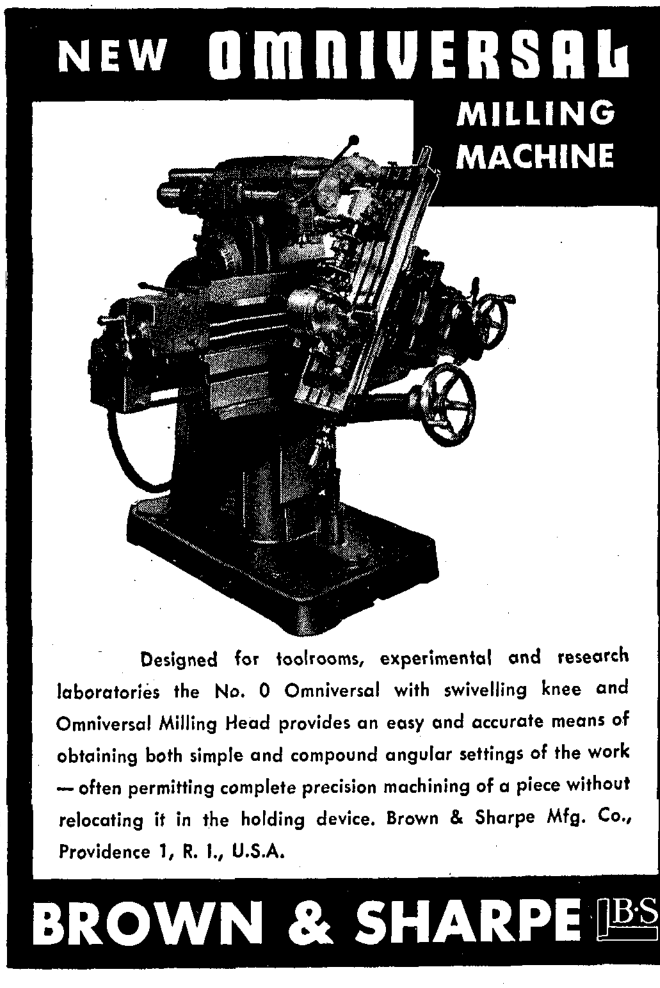
An outstanding patent lawyer, Ward was Student Body President in 1926-27, and President of the Alumni Association in 1937-38.

## Research and Development

RESEARCH AND DEVELOPMENT activities of the Army have been formalized subsequent to World War II, in all arms and services, in the General Staff of the Department of the Army, and in the Organized Reserve. Although not much publicized, Research and Development activities are being stressed as highly important, both in the reservation of skilled manpower for specialized technological duties and in the continual evolution of materiel and scientific knowledge for the armed forces.

In the Organized Reserve, officers are assigned projects appropriate to their experience, in lieu of the military training undertaken in tactical units. Almost without exception, these projects are highly practical. In some instances, individual projects have been completed and have been adopted by the Department of the Army. Other projects have progressed to the point of assuring developments of great value. It is likely that individuals called to active duty will continue comparable assignments.

Reserve officers with appropriate experience are still needed, in all branches. In the Pasadena area where many alumni reside, the 6514th Research and Development Unit is commanded by Colonel Theodore C. Combs, C. E., U. S. A. R. ('27). Interested reserve officers are encouraged to contact him at REpublic 3-9175



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## ALUMNI CALENDAR

**1950-51**

| | |
|---|---|
| April 14 | Alumni Seminar |
| May (date to be set) | Family Picnic |
| June 6 | Annual Meeting |



or SYcamore 6-2164. Elsewhere, reserve officers should contact their local Organized Reserve headquarters for information.

### Outstanding Young Man

ABE M. ZAREM, M.S. '40, Ph.D. '44, Director of Research in the Los Angeles Division of the Stanford Research Institute was one of the ten Outstanding Young Men of 1950 named last month by the United States Junior Chamber of Commerce. Dr. Zarem was cited specifically for his "new photographic techniques making possible the taking of one million photographs a second, for the purpose of research in ballistics and similar fields". The Zarem camera, which he developed for the Navy in 1947, also won Dr. Zarem a 1948 award as the Outstanding Young Electrical Engineer in the United States.

### Alumni Directory

THE 1951 ALUMNI DIRECTORY should be ready for distribution on or about April 1.

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The San Francisco Chapter meets for lunch at the Fraternity Club, 345 Bush Street, every Thursday.

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# PERSONALS

### 1921

*Edward L. Champion*, Vice President of Gibbs & Hill, Inc., consulting engineers, was transferred from the firm's New York office to Los Angeles, to assume direction of the company's western activities on January 1. He is living in Pasadena again, and looking forward to renewing old acquaintances.

### 1922

*Clyde Keith*, after fifteen years in motion picture sound recording work for Electrical Research Products, Inc., and the E. R. P. Division of Western Electric Co. in N. Y., is now employed by Bell Telephone Laboratories at Murray Hill, N. J. Clyde is the retiring Editorial Vice President of the Society of Motion Picture and Television Engineers.

### 1925

*W. Douglas Sellers* of Pasadena, has been appointed public information chairman of the local 1951 Red Cross Fund Appeal.

### 1927

*Dick Mendenhall*, Ph.D., writes from Summit, New Jersey, that he is now selecting instruction, studying text materials, and acting, in general, as a Dean for the Communication Development Training program for new engineers at the Bell Laboratories.

*George E. Moore*, also of Summit, N. J., has been with the Bell Laboratories since his graduation from Tech. He has been working on Physics Research since the war, and before that, on vacuum tube development. George has three children, Kathleen, 15; Stephen, 13; and John, 11.

*Gene Riggs* writes from Rivera, Calif., that he is now engineer for the Downey High School District, and besides inspecting the construction of two new junior high schools, he supervises all maintenance, janitor work, and the operation of school buses.

### 1931

*Paul M. Terry* recently became a Vice President of C F Braun & Company of Alhambra, after twenty one years of service. He started as a surveyor in field operations, headed up the design department for many years, and then the personnel and publicity functions. Paul has a daughter, Phyllis, at Stanford, and a two-year-old son, Steve.

### 1934

*Francis G. Tracy, Jr.*, writes from Carlsbad, New Mexico, that he is on the Board of Directors for the Carlsbad Irrigation District, is a self-employed farmer, and the father of five children—3 boys, and 2 girls.

*John T. Cortelyou* writes from Los Angeles that he is still Building Maintenance Engineer for the Southern California Gas Company.

### 1939

*R. K. Pond* writes that he is keeping busy with programs and arrangements as President this year of the New York Alumni Association. The Ponds bought an old home with a beautiful half-acre lot in Fanwood, New Jersey, last year and are having a big time with improvements inside and out. They have two daughters, one 8½, and one 2½.

### 1940

*Robert L. Wells*, M.S., has been working with the Westinghouse Electric Co. in Pennsylvania since his graduation from Tech. He is manager of the Design and Project Section in the Aviation Gas Turbine Division of the Engineering Department, and says that "several of the newer Navy fighters are powered by our turbo jet engines." Bob's family includes Heidi, 2, and Charles, 3 months.

*Herbert Sargent*, M.S. '44, went to work for the California Research Corp. (Standard Oil of Calif.) in Richmond last October, after being with the U. S. Rubber Company in New Jersey for the past five years. The Sargents have a two-year-old daughter.

*Ludwig Epstein*, M.S. '41, writes from Rochester, N. Y., where he is still working for Bausch & Lomb. He was recently transferred into the thin films and interference filter department however, where he is now free to devote almost all of his time to research problems of his own choosing.

*Marion E. Hines* has been a member of the technical staff at Bell Laboratories since September 1946, where he works on vacuum tube development. The department moved into the new laboratory at Murray Hill, N. J. last summer. Marion was remarried in 1947, and has a son, Sheldon, born August 5, 1949.

### 1941

*Gil Jones*, of Richmond, Va. writes that he is still working for Stone and Webster in Virginia on power station construction projects, and is now certified in both electrical and structural engineering. He is hoping to see a lot of his classmates at the 10th class reunion this year.

*Homer Jacobson* is teaching chemistry at Brooklyn College, and is doing research on the application of information theory to biological receptors, and to linguistic communication. He'd like to hear from any Techmen in the same field.

### 1942

*Kenneth Urbach* is now in the Instrument Engineering Department of the Allen B. DuMont Laboratories in Clifton, N. J.


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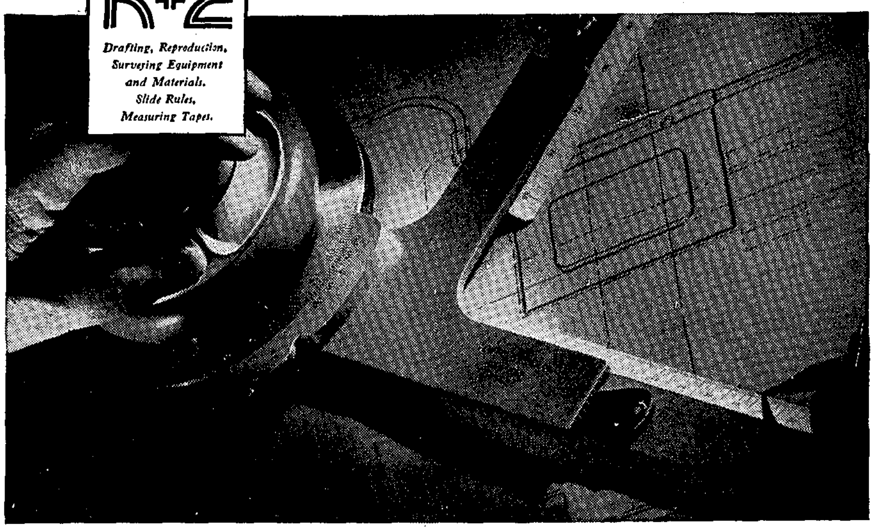

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*Wolfgang Panofsky*, Ph.D., will join the Stanford faculty as Professor of Physics on July 1. He was director of an Office of Scientific Research and Development project from 1942-45, and since then he has been with the Radiation Laboratory and Physics Department of the University of California at Berkeley.

### 1944

*Leon Green, Jr.*, M.S. '47, recently became engaged to Miss Eleanor Samuels of Covina, California.

*William Anderson Tookey* and Nancy Dowling of San Marino were married on December 19. After graduation from Tech, Bill went on to get a law degree from U.S.C.

*Robert G. McAnlis* writes from Lompoc, where he is doing dust control work at the Johns-Manville plant. Bob has two daughters—Kaley Kathleen, 2; and Barbara Lynn, born last November.

*Ralph Babcock Pastoriza*, received his Bachelor of Laws degree from George Washington University, in Washington, D. C., on November 11.

### 1946

*Major John W. Barnes* has had a variety of assignments since he received his M.S. at Tech. Until the summer of 1947 he was Chief of the Demolitions Branch of the Engineer Research and Development Laboratories at Fort Belvoir, Va. The following year he attended the Advanced Engineer Officer Course at Belvoir, then served a year at Fort Churchill in Manitoba, Canada—where he commanded the Engineer Test Detachment and supervised Arctic testing of military engineer equipment. He returned to the U. S. in August 1949, and was assigned at Fort Knox, Kentucky, where he is now instructing in map reading, field engineering, and armored engineer support at the Armored School.

*John Seagrave*, M.S. '48, will be married to Sara Hull Gibson, of Seattle, Wash., next summer. John holds a lieutenant (j.g.) commission in the USNR.

*James L. McCarthy*, formerly with the Bureau of Reclamation at Great Falls, Montana, is now with the Arabian American Oil Company at Dhahran, Saudi Arabia.

### 1947

*Burton Crumly*, M.S. '49, was married to Robyn Hatch in West Hollywood last August. He's now at Stanford—as he was last year—working on his Ph.D. This year, by the way, he holds a Gerard Swope Fellowship from the General Electric Company.

### 1948

*William E. Smyth* writes from Fort Dix, N. J., that he is not pleased to announce that he has become a member of the United States Army pursuant to the selective service.

*Lewis A. Robinson* has been with the Research & Development Laboratories of the Socony-Vacuum Oil Co. at Paulsboro, N. J., since leaving Tech. He is, at present, assigned to the Process Development Section, and concerned with thermofor catalytic cracking engineering studies. The Robinsons are expecting their first family addition in June.

*Conway W. Snyder*, Ph.D. '48, writes from Oak Ridge, Tenn., that he is employed as a Senior Physicist by the NEPA Division of the Fairchild Engine and Airplane Corporation, and will head the research group in the joint ORNL-NEPA Accelerator Laboratory which is now being activated. The Van de Graaff Electrastatic Accelerator, built by the High Voltage Engineering Corporation of Cambridge, Mass., will be set up there during the next three months. Conway says the machine is the first of its kind to operate in excess of five million volts, and it is expected to be turning out nuclear data next summer.

### 1949

*Robert H. Blaker*, Ph.D., formerly of Blue Sulphur Springs, W. Va., had a year of postdoctoral work at the University of Liverpool in England, and is now in the Organic Chemicals Department at Jackson Laboratory, Deepwater Point, N. J.

*James A. McIntosh* writes from Great Notch, N. J., that a daughter, Susan Marie, was born last March.

*Dick Boera*, M.S., writes from the snowy East that he, an engineer, is prospering in his own restaurant business on Staten Island. He wants to pass the word along to all you industrial slaves that there's nothing quite like being your own boss—no matter what the job.

### 1950

*Vic van Lint* is a graduate assistant in Physics here at Tech, with the pleasure of guiding some freshmen through MRW. Vic was married last summer.

*A. E. Larsh, Jr.*, writes that his classmates from Fleming might be happy to know that he has become engaged to Connie Wille "after all these years". Connie is now a senior at the University of California in Berkeley, where Al works in the Radiation Laboratory.

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# LETTERS

## Smoker

In the *Personals* section of E & S for October J. R. Allen '42 admitted he was "active in several southern California pipe smokers clubs, a v.p. in the International Association of Pipe Smokers Clubs" and said he'd be pleased to hear from anyone interested or curious about pipe club activity."

We don't know how many were interested but we got enough queries from curious readers to warrant our asking John Allen for a fuller explanation of life among the pipe clubs—which appears below:

**Sirs:**

Generally, a Pipe Club is a group of men bound together socially by a common interest in pipe smoking and/or (though not necessarily) the collecting of pipes of all sorts.

Aside from the social angle, many clubs have been of service in different channels . . . such as visiting Veteran's Hospitals and distributing smoking materials, talking about and showing pipe collections, and teaching pipe carving.

What happens at a typical meeting? Do we sit around smoking pipes and contributing to the local smog menace? Well, yes, but that's not quite all.

The Two Man Pipe Club of Van Nuys, is just that—2 men. At a recent weekly meeting some visitors were "allowed in on" a heated discussion about how fast to puff on a pipe for best results. All visitors must smoke "Babies Bottom", a mild English mixture.

The largest local club is sponsored by Lockheed Aircraft Company. At their August dinner meeting, members viewed and discussed slides of various famous and rare pipes. An annual picnic for members and families is held in October.

A typical Long Beach Pipe Club meeting will be a Pot-Luck supper followed by a showing of porcelain pipes from member Ed Copeland's famous collection. If time permits, there will be a frenzied pipe-trading session.

The Drag-N-Puff Club met in my den this September, listened to a talk on blending tobacco, then tried mixing up some of their own concoctions from basic tobaccos. The official pipe is the English clay "churchwarden."

Similar activities are followed by clubs in Los Angeles, Santa Ana, Whittier, Monterey Park, and Beverly Hills. Every three months the Southern California clubs hold a joint dinner meeting with the role of host rotating among the clubs.

This local picture is repeated elsewhere in the country, with most clubs being members of the IAPSC, which holds a yearly convention and acts as a clearing house for the exchange of ideas between clubs.

My own deep regard for pipes probably dates from the time I sat in Professor Martel's office, getting some help on a structures problem while one of his countless wastebasket fires blazed away, only casually noticed by him. My pipe has yet to fire up a wastebasket but that doesn't dampen my enthusiasm.

Thank you for this opportunity to sound off on my favorite subject.

*John R. Allen '42*


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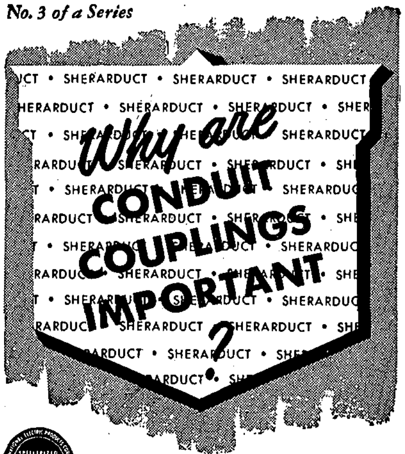
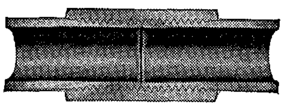
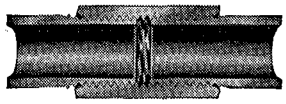



When two lengths of electrical conduit are joined together, ordinarily the point of coupling becomes the weakest part of the run. For this reason the coupling is all-important. And for this reason a Sherardized coupling has special advantages over other types.



SHERARDUCT COUPLING



ORDINARY COUPLING

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# THE INSTITUTE ARCHIVES

A plea to alumni, faculty and friends of the Institute to help build up our archival collections. Have you anything to contribute?

by ROGER STANTON

*Director of Libraries*

PRESIDENT DuBRIDGE recently requested that the Library become the central repository for the Institute archives. It is gratifying to report that the archival materials, accumulated over the years by various Institute offices, have been brought together, at last, from storage closets scattered from cellar to attic, and that they are now housed in a room with special shelving installed to receive them. It is gratifying also to report that a plan is in operation to channel to the Library the voluminous current archival material issuing from faculty, administration, and student body.

Not so gratifying to report are losses from some of the old publication files, and—considering a span of 60 years—the fact that relatively few letters, photographs, programs, and mementos ever have been preserved at all.

This short article is a plea, therefore, to alumni, faculty, and other friends of the Institute to help build up our archival collections. Probably some material is hopelessly lost. Still, the sooner we begin to collect, the better our chances for success.

Most of the losses in the publication files occurred during the war years when packing boxes and bundles were moved from place to place, hurriedly and without supervision, to make room for rapidly expanding defense projects. But the most extensive loss of all, that in the file of the *California Tech,* is due to another cause. Long runs of Tech's weekly paper, stored in the basement of the student houses, were reduced to pulp as the aftermath of an interhouse water fight—or so the story goes.

At all events, the gaps in the publication files are as follows:

I. THE CALIFORNIA TECH
   Volumes I-VI 1912(?)-1917
   Volumes XV-XLVII 1926-1946
   Volume XLVIII 1946: Numbers 1-8
II. THE POLYTECHNIC
   189?-1906
   1908
   1911-1912
III. THE THROOP TECH
   Volume II, Number 3 (Spring number) 1914
   Volume VI, Numbers 1-3, 6-8
IV. LITTLE T
   Volumes 2-5 1920-21 1925-26
   7 1927-28
   9 1929-30
   14 1934-35
   16 1936-37
   23 1943-44
V. COMMENCEMENT PROGRAMS
   1891-1914
   1918-1919
   1925-1937
   1945

If you find any of these items among your belongings, will you please send them to me, as well as any other items of historical value—letters, pictures, programs, or mementos, as mentioned above. Last year, for example, an alumnus of 1895 donated a diploma and a class pin; another donated a copy of the *Throop Institute March* "as played by the Throop Polytechnic Institute Mandolin and Guitar Club" in 1900.

It is surprising how frequently members of the Institute administration and other inquirers consult the various types of archival materials, and for how many purposes. And beside their immediate value is their historical one. Nobody questions that a great deal has happened to Throop University since it was founded in 1891, but where would the unique story be were it not for the year-by-year record of the individuals who made it? And the more detailed the record, the more convincing it becomes as an exhibit of human achievement.

When, hopefully in the not-too-distant future, the Institute has a new library, careful consideration will be given a CIT room to house archives and to exhibit proudly, for all to see, the growth, development, and accomplishments of the California Institute of Technology.

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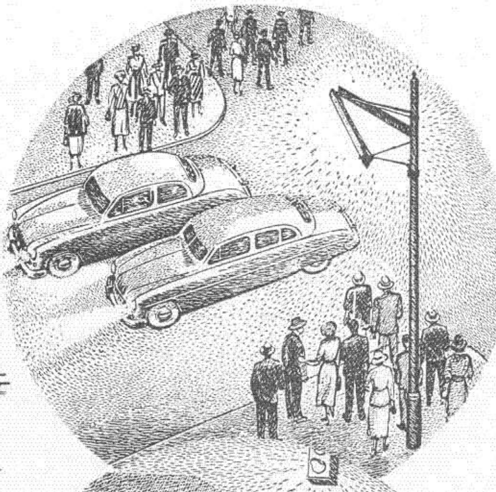
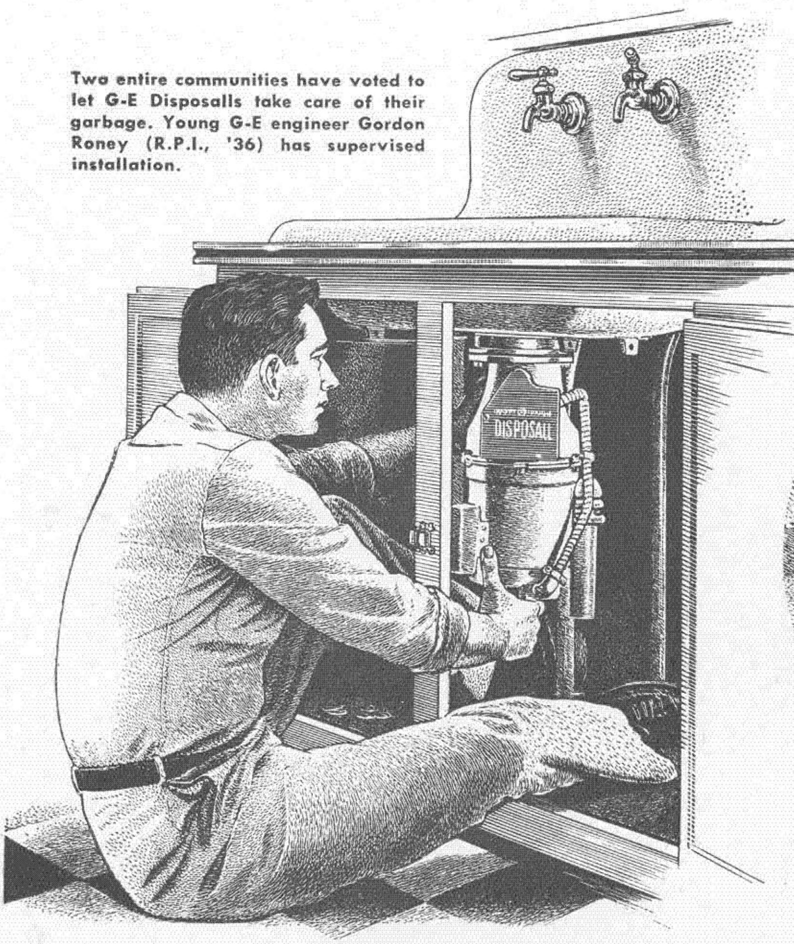
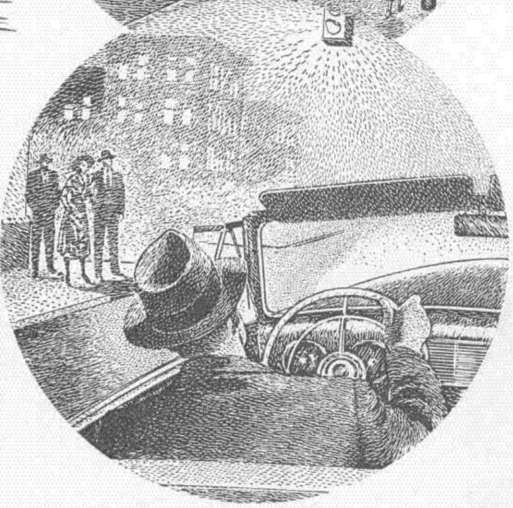


Two entire communities have voted to let G-E Disposalls take care of their garbage. Young G-E engineer Gordon Roney (R.P.I., '36) has supervised installation.



New G-E electronic traffic control automatically adjusts time lights stay red or green to accommodate greatest traffic flow.

# These G-E developments are bringing a "New Look" to American communities

Jasper, Indiana, has no garbage collection any more. It became the first town to get rid of garbage by letting General Electric Disposall® food-waste units grind it up and flush it down the drain. A young G-E engineer who has specialized in Disposalls since he came off the Company's "Test" course supervised the installation of Jasper's units and is now starting a similar job for Herrin, Illinois.

In Detroit, other G-E engineers have installed something new in street lighting—fluorescent street lamps. Used primarily indoors before, fluorescent lamps are now used to light a half-mile of the city's Wyoming Avenue. Their light is brighter, less glaring, and is expected to make driving safer.

Still other G-E experts have revolutionized Denver's downtown system of traffic-light controls. The new system counts passing cars and automatically varies the length of time that red and green lights stay on, thus adjusting the lights to changes in the traffic flow.

These are a few examples of the exciting new projects that are challenging young G-E engineers today. General Electric's leadership in research and engineering makes it a place where college graduates are finding increasing opportunities to engage in highly interesting and satisfying work.

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