appropriate voltages to a main switchroom, from which it is distributed through panel boards to its many purposes. Good lighting must be provided for all equipment, and to the top of even the tallest bubble column. Many of the instruments contain electric devices. In many plants a turbogenerator is installed to start automatically in case of power failure and to maintain at least the minimum light throughout the plant necessary for operation. The instruments are also connected to this emergency power supply.

BUILDINGS

In California it has been found entirely satisfactory to have most equipment, including pumps, in the open. In more inclement climates, however, housing requires a considerable outlay, particularly when the atmospheric temperature hovers below zero for months and is accompanied by heavy snowfalls. Steel frame, corrugated iron covered buildings serve in many locations. For colder regions, reinforced concrete frames with brick walls are often used.

Unit steam heaters or radiators are provided to maintain temperatures in the buildings safely above freezing, and exhaust fans are installed in the walls a short distance above the floor to remove hydrocarbon vapors, all of which are heavier than air. Steel windows and doors are preferred for such substantial buildings. The pipelines of many sizes and purposes are supported from the beams of the floor above, and others are brought to the pumps in trenches, sunk below the floor, covered with steel plates or gratings and connected to the sewer.

Compressed air must be available for instruments, dried in special vessels, when the climate is such that moist air might freeze in small air lines, for the blowing of sulphuric acid from vessel to vessel and for other purposes. Air compressors with accumulators must therefore be provided.

Heavy and tall structural steel supports are needed for certain portions of the refrigeration equipment, for the contactors, and for the reactors in the isomerization plant. All bubble towers must be made accessible throughout their height by means of steel ladders and platforms. Operating walkways over some of the horizontal vessels add to the use of structural steel.

In order to conserve heat and to better maintain the necessary operating temperatures, many bubble columns, heaters, turbines, pipelines and other units of the equipment are insulated. Cold insulation is required on all equipment operating at lower than atmospheric temperature.

COOPERATION

It should be pointed out that no two plants of the same size will require identical equipment. The exact composition and purity of the charging stocks determine the operating cycle and equipment. The type of foundation, the type of building construction, the type of power source to be employed will depend upon the local conditions prevailing at the plant site.

The construction and the assembly of the equipment for a plant to accomplish these operations is a challenging undertaking. Laying the plans and putting them into operation requires the cooperative effort of chemical, mechanical, civil, electrical, construction and metallurgical engineers, as well as purchasing personnel. This is typical of an extensive engineering job involving diversified activities.

C. I. T. NEWS

IN PRAISE OF TRUSTEES

By ROBERT A. MILLIKAN

On January 24 a dinner was held at the California Club to honor James R. Page, recently elected President of the Board of Trustees of the California Institute of Techonology. Dr. Millikan's remarks at that dinner are presented here because it is believed that the readers of ENGINEERING AND SCIENCE will be interested in the part a Board of Trustees is playing in the operation of one type of war industry.—Editor.

YOUR HOSTS are the Trustees and I am sure you want to know what manner of job they do. Being very modest men they will not tell you, but I have insisted on being given a few minutes to do so, for I am not on the Board and I can properly speak "In Praise of the Trustees."

The fact that they have always maintained the policy that no salaried employee can be a board member, or indeed have a vote on its finance committee, reveals in itself the seriousness and the long-range wisdom with which they take their job in the rendering of a wholly free public service to the community and the nation.

Let me first say something in general about the genus "Board of Trustees," for our higher educational system in the United States consists of much more than a thousand of these privately supported colleges and universities all over this land created wholly by private initiative and controlled entirely by Boards of Trustees operating under charters granted by 48 states. Here is the free democratic American way of life at its best—free from all possibility of political influences. It is the finest expression of the free-enterprise system here consisting in the self-education of each community in the finding and meeting of its own educational needs, the most fundamental of its needs. Add to these private institutions the much smaller number of our tax-supported institutions created by the communities of 48 different states—it is in the number of these states that freedom's safety lies—and there has still been maintained the principle of local self-government in our higher educational system. This is the cornerstone of the freedom which we are fighting this great war to preserve.

With any centralized system of education such as is characteristic of all totalitarian states, it is inevitable, as the recent history of the world amply demonstrates, that education becomes replaced by indoctrination in the interests of the perpetuation of the power of the group in control of government, and freedom is destroyed at its source.

These Boards of Trustees are, then, the most potent guardians of the liberties of the American people. No higher praise than that can be accorded to any group. The greatest menace to the future of the United States is just now the terrific pressure for the encroachment of the federal government upon our educational system. According to the founding fathers and the teachings of history, the federal government exists, and should exist, primarily for defense against external aggression.

I hope that what I have said so far is sufficient to scotch the idea that the men chosen to sit on Boards of Trustees are chosen primarily because they have had long and successful training and experience as community pickpockets.

To further illustrate the responsibilities of Trustees in general, let me give you the definition of the functions of our American system of higher education. It has a two-fold function, first, to pass on to the coming generation the torch of the accumulated knowledge and understanding of the past, and second, to increase the store of knowledge to be thus transmitted. Higher educational institutions are by definition, then, teaching and research institutions. They divide their activities between these two functions differently, as they may well do.

Now, turn to the answers to the question, what is this particular Board and what does it in particular do? It consists of 19 men, viz., President Page and Vice-Presidents Macbeth, Cravens, and Harvey Mudd, and the following members: Harry Chandler, Harry Bauer, Ben Meyer, W. L. Honnold, George Farrand, William McDuffie, P. G. Winnett, John O'Melveny, Albert Ruddock, George Grant Hoag, Ralph Lloyd, Reese Taylor, Robert Gross, Norman Chandler, and Keith Spalding.

On account of the present national emergency, the responsibilities that are now upon these men have increased enormously, making unusually large demands upon their business acumen and financial and administrative experience and skill. The research activities of C.I.T. are now largely concentrated on war projects assigned to it by the military arms of the U. S. government. These assignments are made through about 50 war contracts involving many millions of dollars which have required the appointment of a special contracts committee consisting of Alexander B. Macbeth, John O'Melveny, and Reese Taylor—a committee which meets often, studies the contracts, negotiates changes when it disapproves their form, and finally recommends them for action by the Board, which in this emergency is meeting the first Monday in each month.

The carrying out of these contracts has involved an enormous expansion of the personnel of the Institute, its paid employees numbering now 3400, not counting any of its 1200 students. Its work is now being carried on on 14 different campuses, without counting any of the 180 Los Angeles industrial concerns to which it has let subcontracts. These campuses are, first, its central campus on California Street between Wilson and Hill Streets, where the Trustees have a seven million dollar plant to conserve; second, the Palomar campus involving an investment of nearly the same magnitude; third, the Kerckhoff Marine Biological Laboratory at Corona del Mar, where Dr. Morgan has done much of his work in recent years and where primitive forms of life are found in abundance; fourth, the Seismological Laboratory near the Annandale Golf Club, a part of the Balch Graduate School of the Geological Sciences, and a most active and fruitful center of our growing and useful knowledge of earthquakes and the interior structure of the earth; fifth, the Kerckhoff Genetics farm at Arcadia, where the genetics of, and improvements in corn are now under intensive attack, with the aid of all the knowledge of genetics developed in the Kerckhoff Laboratories on the main campus.

The next five campuses are war campuses involving many hundreds of workers and between one and two hundred new temporary buildings, mostly of wood. Two of these are out in the desert and three are in canyons in the surrounding mountains.

Three more war campuses are inside the limits of Pasadena but off the main campus, and represent new temporary testing and inspection laboratories, machine shops, and transportation facilities which take care of the flow of material in and out between C.I.T., their ultimate destination, and the 180 Los Angeles subcontracting businesses that supply parts.

The fourteenth and last of these campuses is the two and a quarter million dollar so-called cooperative wind tunnel near the Pasadena light and power plant which will be in operation in a very few months. It will be the first wind tunnel in the United States capable of testing the performance of airplanes for speed ranges of from 400 to 750 miles per hour, which latter figure is the speed of sound.

That is the kind of a job these Trustees are now handling. It will give you some idea of what the plant protection committee, consisting of Trustees Macbeth, Ruddock, and Cravens, has had to do this last year; of the responsibility which the finance committee, meeting every two or three weeks and consisting of Trustees Page, Mudd, Meyer, Bauer, and Macbeth has on its shoulders; these committees, plus the contracts committee consisting of Trustees Macbeth, O'Melveny, and Taylor, report directly to the Board. The Institute has no president but its normal work of supervision of the whole is done by the Executive Council consisting of eight: Trustees Page, Mudd, McDuffie, and Macbeth, and Faculty Members Munro, Mason, Tolman, and Millikan, plus Comptroller Barrett. These Trustees have just elected as captain of the whole enterprise a man who has spent for years, as have most of the Trustees, an immense amount of time running errands as the right sort of a Page is supposed to do, not merely for C.I.T. but for the War Chest, the Community Chest, the Automobile Club, the All-Year Club, the religious organizations of the city, and I don't know how many other Los Angeles activities that require brains, judgment, business experience, and devotion to community-development enterprises.

CALTECH PROFESSOR NAMED TO STATE PERSONNEL BOARD

Governor Earl Warren announced early in April the appointment of Robert D. Gray, professor of economics and industrial relations at the California Institute of Technology, to be a member of the State Personnel Board. Professor Gray succeeds John J. Hamlyn for a term ending January 15, 1943.

Professor Gray came to Caltech three years ago to take charge of the industrial relations section at the Institute which was organized to aid in the gradual improvement of relations between employers and employees. A native of Warren, Pennsylvania, he was graduated from the University of Pennsylvania in 1930 and continued part-time graduate work and research work at the university until 1936. He then held the post of assistant professor of economics at the University of Connecticut.