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COVER

El Misti Volcano, with city of Arequipa, Peru, in foreground. The lavas, together with those of the numerous stratovolcanoes along the Pacific coasts of North and South America, are predominantly andesite. Geochemical studies show that the El Misti lavas contain a component from rocks of the Precambrian basement on which the volcano sits. See page 1245. [G. R. Tilton, University of California, Santa Barbara]

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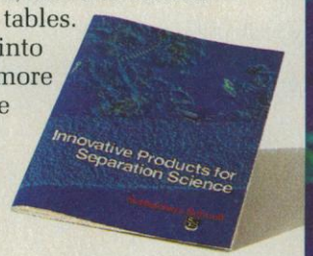

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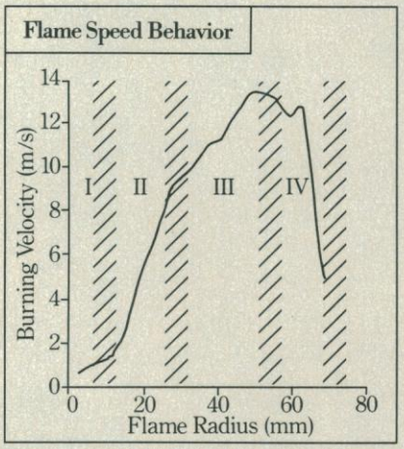
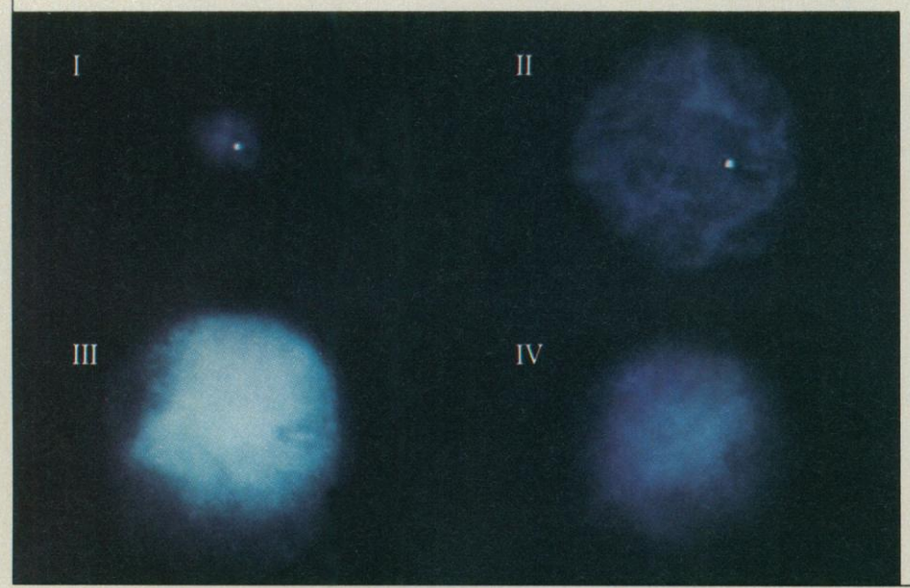
The Turbulence Parameter

The Turbulence Parameter

Energy-efficient operation of the internal combustion engine requires the highly turbulent movement of fuel and air in the chamber. Recent advances at the General Motors Research Laboratories provide a new basis for determining what degree of turbulence will get the most work from each drop of fuel.



Burning velocity plotted as a function of flame radius. Combustion stages are indicated by roman numerals.



High-speed photographs showing flame evolution (lasting six milliseconds) through four stages: initiation (I); flame growth (II); full development (III); termination (IV).

WITHOUT TURBULENCE, the highly agitated motion of cylinder gases, combustion would take place too slowly for the gasoline engine to function. Predicting combustion behavior in order to design engines with greater fuel efficiency depends upon understanding the relationship between vital, turbulent gas motions and burning rate. The challenge is to quantify this relationship—a complex task made more difficult by the requirements of measuring a transient event occurring in a few milliseconds within a small, confined space.

New knowledge of how turbulence affects flame speed has been revealed in fundamental studies conducted at the General Motors Research Laboratories by Drs. Frederic Matekunas and Edward Groff. Their investigative results have been incorporated into a model that successfully predicts the effect of engine design and operating conditions on power and fuel economy.

The researchers separated their experiments into two phases. In the first phase, they measured turbulence in the engine cylinder; in the second phase, they determined flame speeds over a broad range of operating conditions. Testing took place in a specially designed, single-cylinder engine equipped with a transparent piston to permit high-speed filming of the combustion event.

Hot-wire anemometry was applied to measure the turbulent flows while the engine was operated without combustion. Instantaneous velocities were calculated from the anemometer signals and simultaneous measurements of gas temperature and pressure. More than 400,000 pieces of data were processed for each ten-second measurement period.

The significant measure of turbulence is its "intensity," defined as the fluctuating component of velocity. Because conditions in the cylinder are both transient within cycles and variant between cycles, separating the fluctuating and mean components of velocity is inherently difficult. The researchers overcame this problem by using a probe with two orthogonal wires properly aligned with the direction of the mean flow.

In the combustion phase, tests were performed at over one hundred operating conditions of varied spark timing, spark plug location, engine speed and intake valve geometry. Detailed thermodynamic analyses were applied to the recorded cylinder pressures to calculate flame speeds throughout combustion. High-speed films were analyzed frame by frame to validate flame speeds and to characterize how gas motions influence the initial flame.

The researchers used these measured flame speeds, turbulence intensities, and the conditions under which they occurred to formulate a burning law for engine flames. They divided the combustion event into four stages. The initiation stage begins with ignition and ends as the flame grows to consume one percent of the fuel mass. In the second stage, the flame accelerates and thickens in response to the turbulent field. The third stage exhibits peak flame speed. In the final stage, the thick flame interacts increasingly with the chamber walls and decelerates.

OVER THE RANGE of turbulent intensities encountered in engines, the researchers were able to describe the turbulent burning velocity, S_T, during the critical third stage of combustion with the expression:

$$S_T = 2.0\, S_L + 1.2\, u'\, P_R^{0.82}\, \beta$$

S_L, the laminar flame speed—a known function of pressure, temperature and mixture composition—is the flame speed that would exist without turbulence. The variable u′ is the turbulence intensity. P_R represents a pressure ratio accounting for combustion-induced compression of the unburned mixture. The dimensionless factor β accounts for the effect of spark timing on geometric distortion of the flame which occurs during the first combustion stage and persists into the later stages.

The researchers also observed that the burning velocity in the second stage increases in proportion to flame radius, and that in predicting the energy release rate from the burning velocity equation, it is necessary to account for the finite flame-front thickness.

"The form of our burning equation," says Dr. Matekunas, "shows a satisfying resemblance to expressions for non-engine flames. This helps link complex engine combustion phenomena to the existing body of knowledge on turbulent flames."

"We see this extension," adds Dr. Groff, "as a significant step toward optimizing fuel economy in automotive engines."

THE MEN BEHIND THE WORK

Drs. Matekunas and Groff are senior engineers in the Engine Research Department at the General Motors Research Laboratories.

Both researchers hold undergraduate and graduate degrees in the field of mechanical engineering.

Dr. Matekunas (right) received his M.S. and Ph. D. from Purdue University, where he completed graduate work in advanced optics applications.

Dr. Groff (left) received an M.S. from California Institute of Technology and a Ph. D. from The Pennsylvania State University. His doctoral thesis explored the combustion of liquid metals.

General Motors welcomed Dr. Matekunas to its staff in 1973, and Dr. Groff in 1977.

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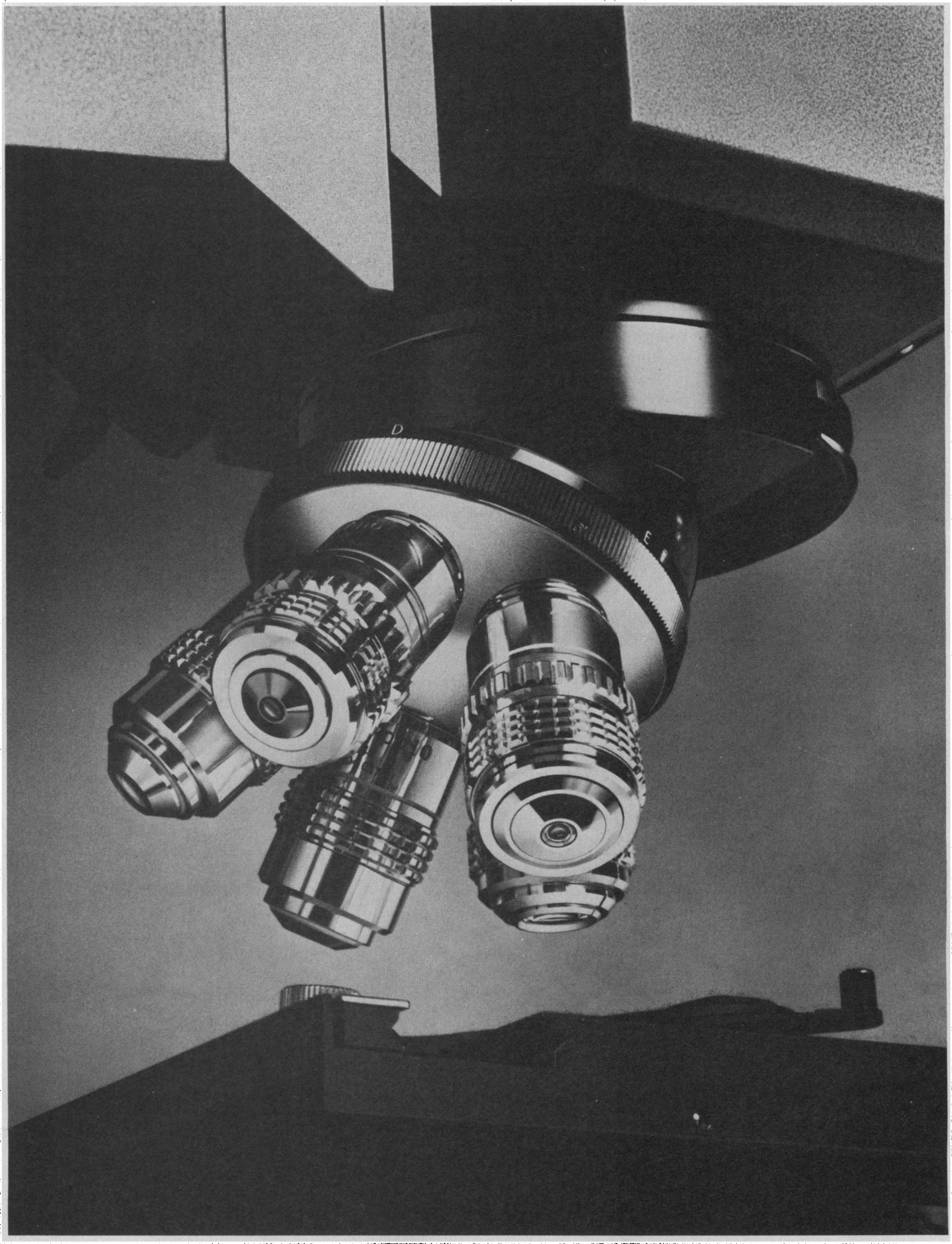

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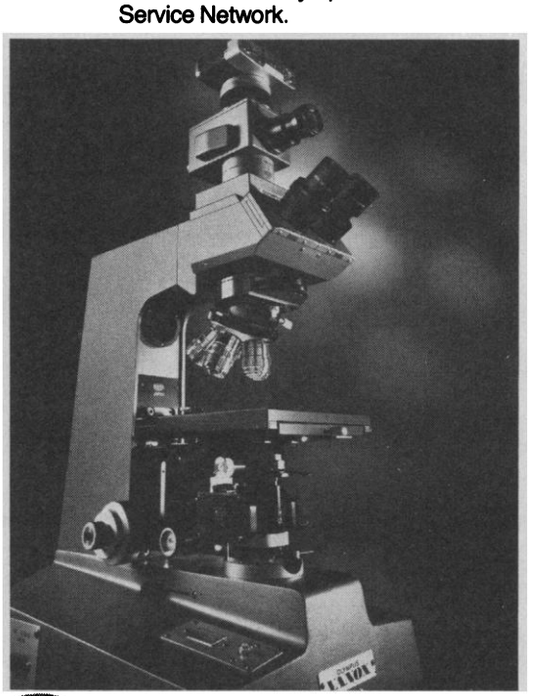

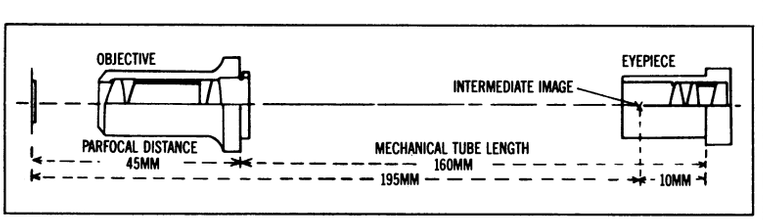

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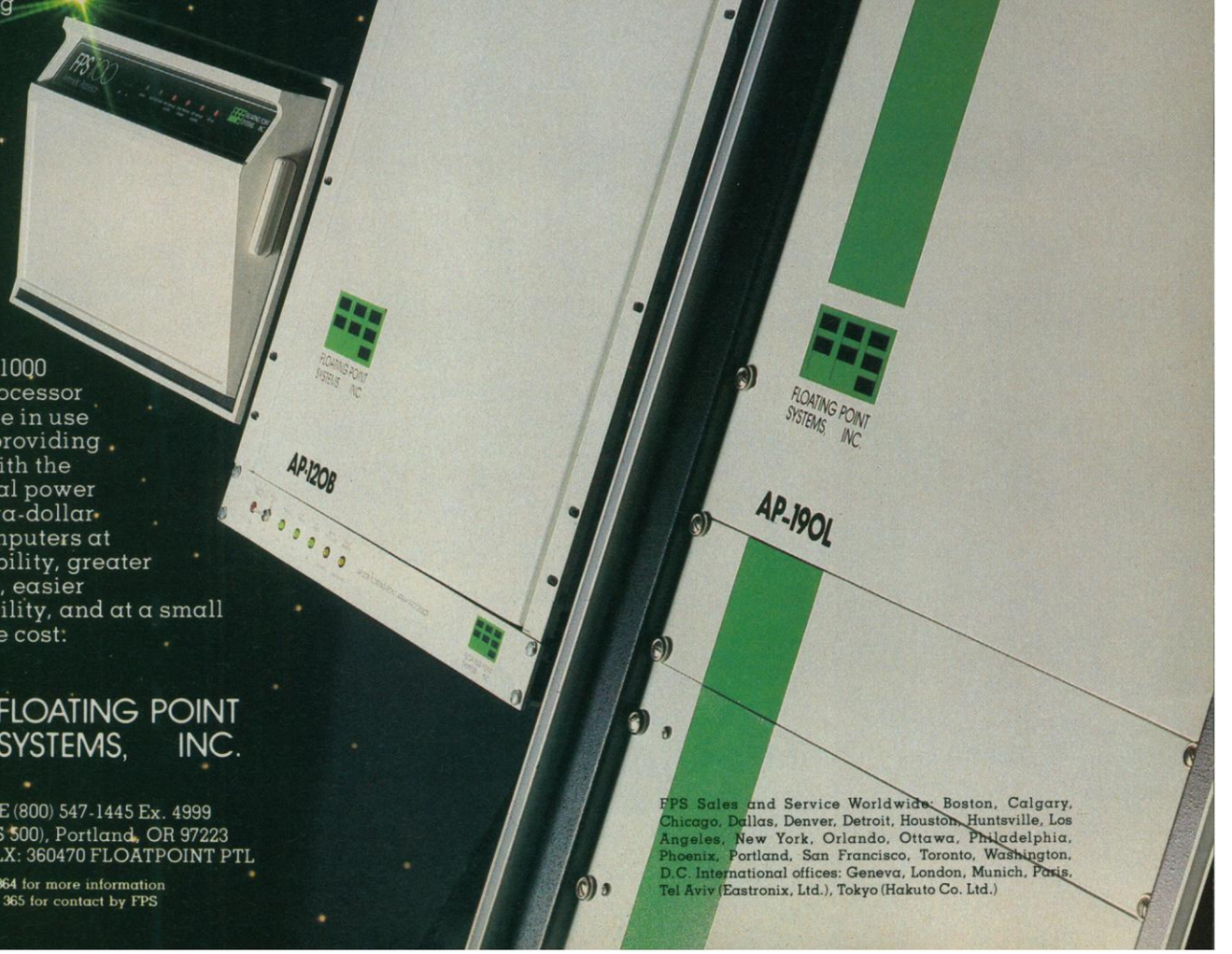

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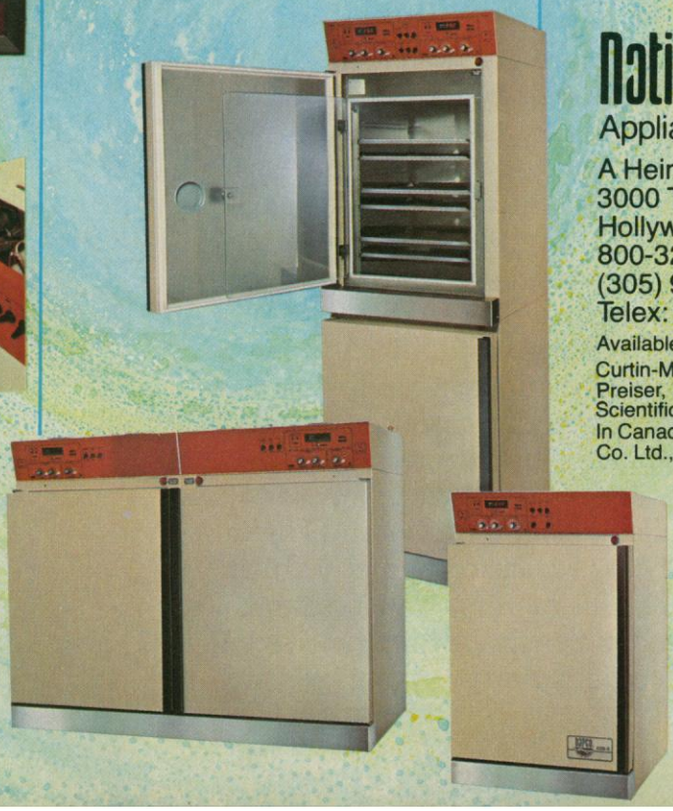

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OSTP: The Last 4 Years

An article entitled "Frank Press's number game" (News and Comment, 24 Oct., p. 406), suggests that Frank Press and his staff at the Office of Science and Technology Policy (OSTP) may have distorted budget data in order to overstate President Carter's record in support of basic research. Fairness requires me to clarify the record about the data on the Administration's support for basic research and Press's testimony before my subcommittee on 19 September.

Subsequent to the hearing, information was provided to the subcommittee by the OSTP which confirmed that the growth of support for basic research in constant 1972 dollars between fiscal years 1979 and 1981 (March) was slight, as was also reported in Willis Shapley's analysis for the AAAS. Press's testimony indicated, however, that the Carter Administration's 4-year record, that is, for fiscal years 1978–1982, would exhibit real growth in basic research of 11 percent. From the information I now have, it appears this increase depends largely on the new funding for fiscal years 1981 and 1982 promised in the President's August 1980 economic message.

I don't question Press's good faith, nor the intentions of the Carter Administration. But the record of support for basic research in 1981 and 1982 will now depend on the Reagan Administration and the new Congress.

The real message of the budget figures is that, while support for basic research was increasing significantly in current dollars under President Carter, the impact of inflation cut away those gains.

The relationship between Press and my subcommittee has been close, cordial, and mutually supportive. Press made the most of a difficult, understaffed assignment and deserves the gratitude of all who attach a high priority to the health of science in the United States.

ADLAI E. STEVENSON
Subcommittee on Science, Technology, and Space, Committee on Commerce, Science, and Transportation, U.S. Senate, Washington, D.C. 20510

The Office of Science and Technology Policy has received some comment in recent letters to the editor (21 Nov., p. 846). I wish to add something on a positive note. During the last 4 years there has been important interaction established by the OSTP with the industrial research community. Furthermore, this interaction was carried out without any adversarial relationship, which sometimes obtains in the interaction between industry and some federal agencies. The interactions were frequent and led to involvement of many industrial researchers in activities such as the Domestic Policy Review on Technological Innovation. We in the industrial R & D community feel that our voice has been heard and that we have made a contribution. We do not represent a single narrow interest, but a broad spectrum of industrial science and technology important to the economy of the United States.

We trust that this relationship may continue with the incoming presidential science adviser.

JULES BLAKE
Industrial Research Institute, 100 Park Avenue, New York 10017

Chestnut Blight

American plant pathologists who are seeking a control for chestnut blight (Research News, 22 Aug., p. 892) must objectively examine two aspects of the French literature on hypovirulence (*1*, *2*). Foremost are the subjective statements by Grente and Berthelay-Sauret (*1*) that there is a direct relationship between the relative recovery of blight cankers on European chestnuts in Italy and the relative abundance of strains of the fungus with infectious hypovirulence. These statements are the basis for the hypothesis that an infectious hypovirulence agent is the mechanism for biological control of chestnut blight in Europe. If this direct relationship exists, objective experimental data should be presented to confirm it.

A second problem is the absence of experimental data in reports (*2*) of the successful control of the blight on European chestnuts in French orchards. To confirm that a control treatment is effective, the treatment must be compared with suitable check treatments. The French reports do not indicate any such comparisons were made. In the absence of check treatments, there is no basis for establishing the relative effectiveness of a control treatment.

Infectious hypovirulence in a plant parasitic fungus is not unique to the chestnut blight fungus *Endothia parasitica*. Lindberg (*3*) reported hypovirulence in *Helminthosporium sativum* in 1959. Recently it was reported in *Rhizoctonia solani* and *Gaumanomyces graminis* (*4*). Although these authors have speculated that hypovirulence may provide biological control, they have not

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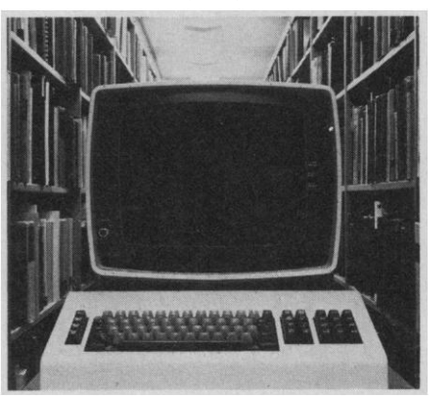

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demonstrated it. The U.S. Forest Service is supporting research to critically evaluate the potential of hypovirulence in *Endothia parasitica* for biocontrol in the United States. This research may or may not confirm the interesting hypothesis of Grente and Berthelay-Sauret, but it should give us a sound basis for that determination.

E. G. KUHLMAN
Forest Sciences Laboratory, U.S. Forest Service, Research Triangle Park, North Carolina 27709

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Paleontologists and Continental Drift

However alluring the image may be of a bunch of mossback paleontologists being dragged kicking and screaming into acceptance of continental drift by those clever geophysicists, it represents a simplified piece of revisionist history (Research News, 31 Oct., p. 514).

Before Wegener, the father of continental drift theory, paleontologists and biogeographers were faced with a difficult problem in explaining in terms of Darwinian evolution the demonstrably close affinities of living and certain fossil biotas on widely separated continental areas, especially in the Southern Hemisphere. In his classic work *The Origin of Continents and Oceans*, Wegener writes that he only took seriously implications for the coastline fit of South America and Africa after examining paleontological evidence for a former land bridge between the two continents. Paleontological and biogeographic data make up a major portion of the arguments that Wegener marshaled in favor of continental drift, even to the timing and rough sequencing of separation events. His proposal of continental displacements, rather than of the transoceanic land bridges seemingly required by organisms, represented a major simplification of the perplexing evidence of vertebrate paleontology, paleobotany, and biogeography. The villains of this piece turned out to be the geophysicists, who disposed of his theory on grounds of crustal rigidity and the lack of a sufficient motive force.

In the case of the asteroid theory of extinctions, what some paleontologists, including myself, are objecting to is not the possibility of an extraterrestrial impact but to some of the more extreme flash-frying, mass-gassing (*1*), or lights-out (*2*) scenarios attributed to it.

LEO J. HICKEY
Division of Paleobotany, Smithsonian Institution, Washington, D.C. 20560

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Communicating Scientific Data

Philip H. Abelson, in a recent editorial (17 Oct., p.255), raises a number of complex issues for both scientists and those who are engaged in the design and planning of the information systems for the future.

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Despite the above, we feel that the future of the scientific journal is not so gloomy. In fact, the printed form of *Biological Abstracts* and our other information publications continue to provide the fundamental revenues that make our electronic communication media possible. In those areas of the world not presently benefiting from the electronic form of distribution, the information must be available in more conventional garb. Further, the refereeing process in connection with conventional publication remains an essential value of the scientific documentation system.

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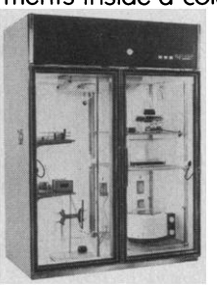

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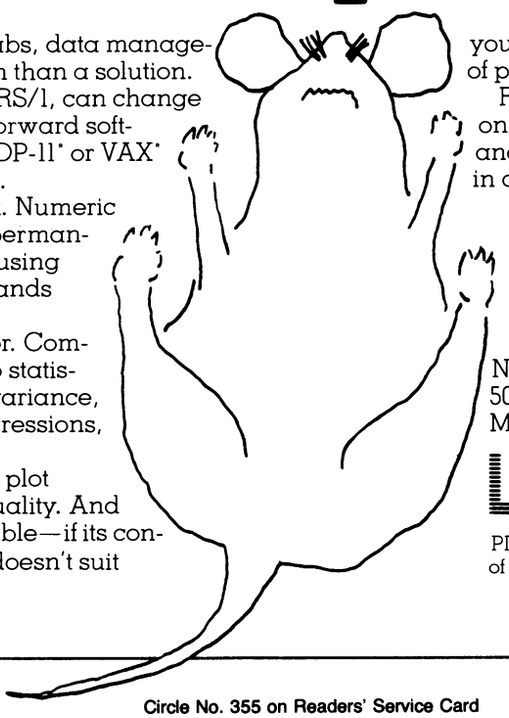

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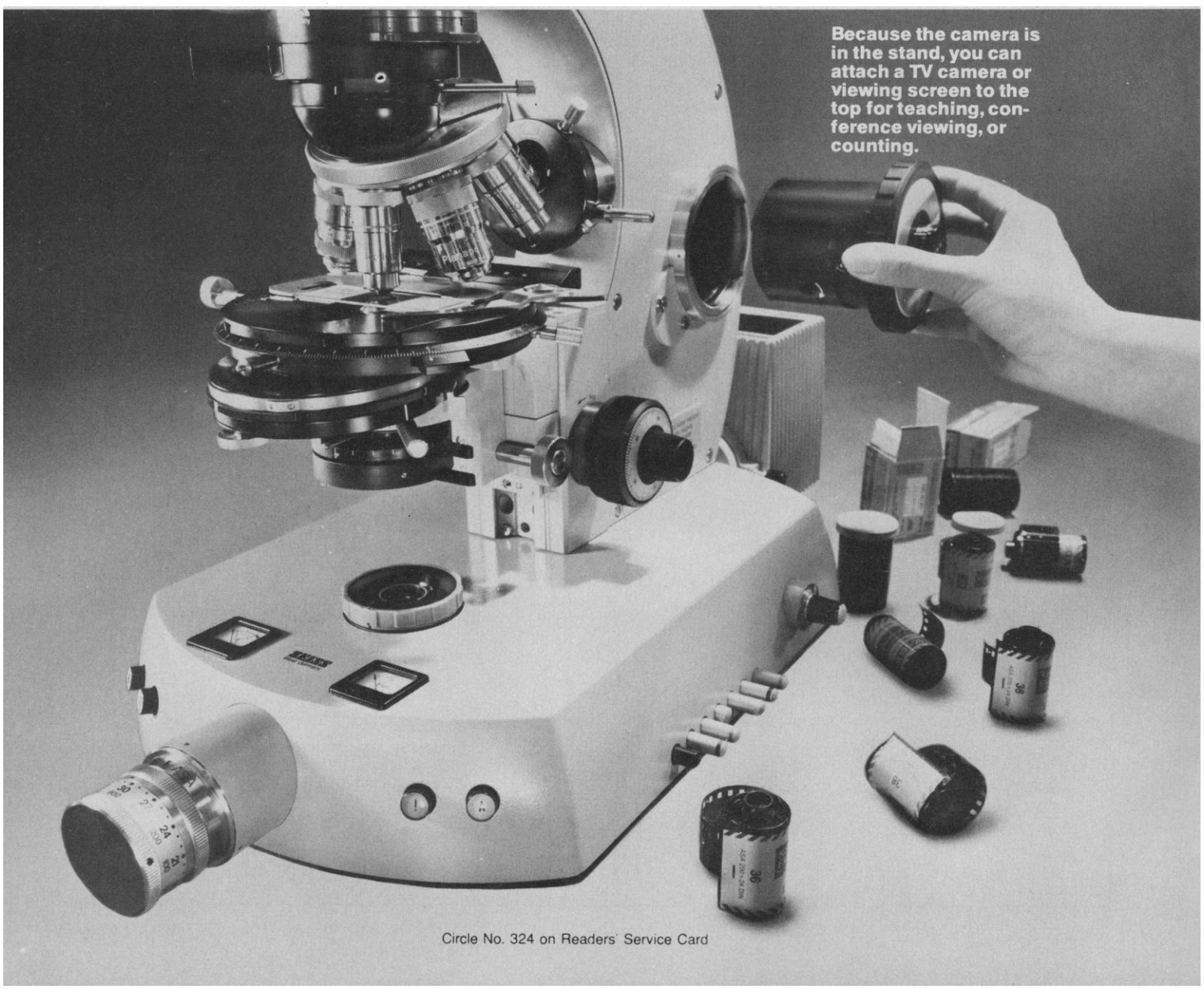

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Eradication

The ultimate step in the control of any disease is its eradication worldwide. This earthshaking goal has been achieved only in the case of smallpox. The last case of epidemic smallpox occurred in November 1977. The sole reported case thereafter was the result of a deplorable laboratory accident. Smallpox was an excellent candidate for eradication. It was a disease that caused high mortality and the survivors were often badly scarred. There had been a long history of major epidemics. There was an effective, stable, and thoroughly tested vaccine, and the immune population was generally identifiable. There was no known animal reservoir, nor was there a significant carrier state. The disease had been shown to be controllable by vaccination in many countries. Nonetheless, doubts about the outcome of the eradication campaign were initially expressed, even by actively participating scientists. The control of smallpox, before its eradication, imposed a continuing burden both in dollars and in health hazards. Despite most effective programs of immunization and quarantine, occasional outbreaks resulting from importation were inevitable. With eradication of the disease, this burden has been permanently removed and the savings thus effected extend in perpetuity.

The history of smallpox makes it attractive, indeed mandatory, to consider other diseases that may be ripe for eradication. This was the subject of a conference held in the Fogarty International Center at the National Institutes of Health on 27 and 28 May. Attention was given primarily to infectious diseases for which there exist means of interrupting transmission of the infectious agent from person to person. These means might include immunization of the susceptible population, antibiotic treatment of the infected population, or elimination of an obligate vector. Of the several diseases considered, the three that received the most attention were measles, poliomyelitis, and yaws.

A major effort is now being made in the United States to control measles. If it proves successful, as is generally expected, worldwide eradication of the disease and elimination of its serious consequences, such as subacute sclerosing panencephalitis, should also be possible. Measles differs from smallpox in a number of important ways. Although measles is considered a trivial disease in certain countries, it is a serious health problem in some developing areas of the world. Measles vaccine is relatively thermolabile and requires hypodermic administration. Measles is highly infectious and does not provide stigmata of prior disease.

There is ample evidence from many countries that poliomyelitis can be controlled by adequate immunization. The selection of the most appropriate vaccine for this disease is still in dispute, and satisfactory immunization in certain underdeveloped nations has yet to be demonstrated.

For yaws, a chronic and highly infectious skin disease caused by *Treponema pertenue* and seen most frequently in the tropics, the procedure would be entirely different. There is no satisfactory immunization at present. However, victims of yaws can be rendered noninfectious by a minimal course of penicillin, thereby interrupting the spread of the disease.

Man has proven himself to be effective in the extermination of other species. We no longer have the dodo bird, the great auk, or the passenger pigeon. We may now add to these extinct species the variola virus, except for that stored in freezer chests in several countries. Among the species of animals now threatened with extinction are the Bengal tiger, the sperm whale, and the white rhinoceros. Would it not be preferable to eliminate instead the measles virus, the poliomyelitis virus, and the *Treponema pertenue* of yaws?—DEWITT STETTEN, JR., *National Institutes of Health, Bethesda, Maryland 20205*

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