of the country. The remains of these floras are of various ages, some of them as young as Pliocene. The greatest number of species was found in the Lower Oligocene in the vicinity of Lake Nor Zaisan in Kazakhstan. An especially rich find was the Sarmatian flora near the Black Sea. The Lower Pliocene flora found in the Goderz pass numbers about one hundred varieties. Investigation has shown that in some places floras of different types existed simultaneously, a fact which disrupts the principle of Homotaxis.

A lot has been done by way of studying Quaternary floras in ancient peat deposits. The chief features in the development of the Pleistocene floras have been described and analyzed by Academician V. N. Sukachev. The method of pollen analysis has given good results in studying the past of plants. Dr. A. Yarmolenko's work on plant anatomy is worthy of special note.

About thirty specialists have been working in the sphere of paleobotany for the past twenty-five years. We have suffered a number of losses in our ranks on account of the war. Active workers in the field to-day are: Dr. M. Z. Brits (Tashkent), Professor A. V. Hachlov (Tomsk), Professor B. V. Baranov (Kazan), Professor Kristofovich (Leningrad), Dr. E. N. Kara-Murza (Leningrad), Dr. S. N. Naumova (Moscow), Professor L. M. Krelshchetovich (Moscow), Professor M. T. Neuberg (Moscow), Professor T. B. Novopokrovsky (Rostov-on-Don), Professor P. A. Nikitin (Novosibirsk), Professor T. W. Palibin (Leningrad), B. V. Prynada (Irkutsk), Dr. G. P. Radchenko (Moscow), Dr. I. M. Pokrovskaya (Leningrad), Dr. M. T. Chirkova (Moscow), Dr. A. I. Turutanova (Leningrad) and Academician V. N. Sukachev (Moscow).

I. V. PALIBIN

WEAR IN ENGINE CYLINDERS

IN an illuminating and thought-provoking booklet entitled "Wear," D. Landau, industrial applications engineer with the Nitralloy Corporation, has discussed, as one of the topics in his treatise, the wear in cylinders and pistons. As Landau points out, this problem has received a great deal of attention at the hands of automotive engineers and merits this emphasis because of its importance.

In Fig. 1 is shown Fig. 5 from Landau's article; it indicates that "The greatest wear occurs at the top end of the piston travel under the topmost ring and decreases from there down." At this upper point the piston has the maximum pressure applied and at the turning point it is at rest for an instant. No matter how closely the piston rings are fitted some of the compressed gas[1] gets past them, so that at the upper end of the travel of the piston the best conditions exist for the passage of the gas particles between the piston ring and the cylinder at an enormous speed for these gas particles. At the instant the piston stops at the upper end of the stroke more gas gets by and at a higher velocity than at any other

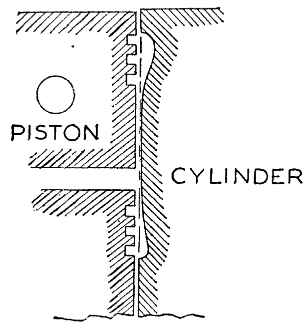

FIG. 1. Taken from Landau's article. (Fig. 5.) The greatest wear on the cylinder comes at the upper end of the stroke.

point along the path of travel of the piston in the cylinder. This is exactly where the greatest wear comes, as Landau has pointed out.

I should like to raise with automotive engineers the question as to how much of a role the forces arising from the principle of Bernoulli comes into this picture?

The principle of Bernoulli[2] states that in a state of steady flow of an incompressible fluid the hydrodynamic pressure will be least where the velocity of flow is greatest. The old Venturi meter, Fig. 2, is a good illustration. The rate of flow at 2 is greater

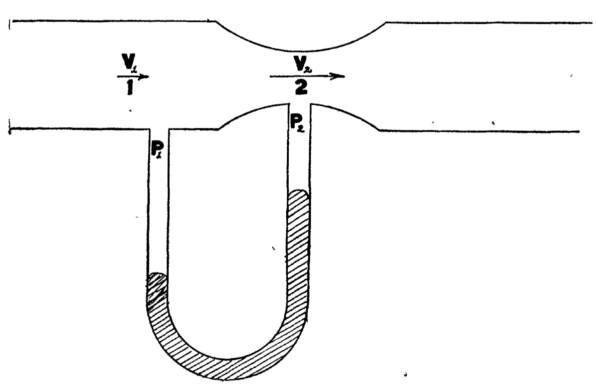

FIG. 2. Venturi meter for water. The velocity of flow at 2 is greater than at 1 and, therefore the pressure P_2 is less than P_1.

[1] Some oil particles are also forced past the piston rings, but as Taub points out, when oil is lacking the wear is greatest and the reason is to be found in part by this high speed of travel of the gas particles past the piston rings. Alex Taub, *Automotive and Aviation Industries,* March 1, 1944.

[2] See *Scientific American,* October and November, 1927.

than at 1, but at 2 the pressure (seemingly paradoxical) is less than at 1. Fig. 3 shows a filter pump, sometimes called an aspirator. As the stream of water (W) flows through the narrow portion of the aspirator (N), the speed is increased, but at the same time the pressure is reduced. When the water emerges at the lower end (E) of the aspirator it is again at atmospheric pressure, as is the case at (A). Therefore, there is a decrease in pressure from the inlet at A to the narrow channel N and so air begins to move in toward the point of lower pressure and becoming entrained in the water is carried out as A at the lower section of the aspirator. As the water moves through the narrow channel it is picking out the air particles coming in at A and at the same time this same force is acting upon the particles composing the brass aspirator itself and slowly picking them off, while the air moves in in large volume.

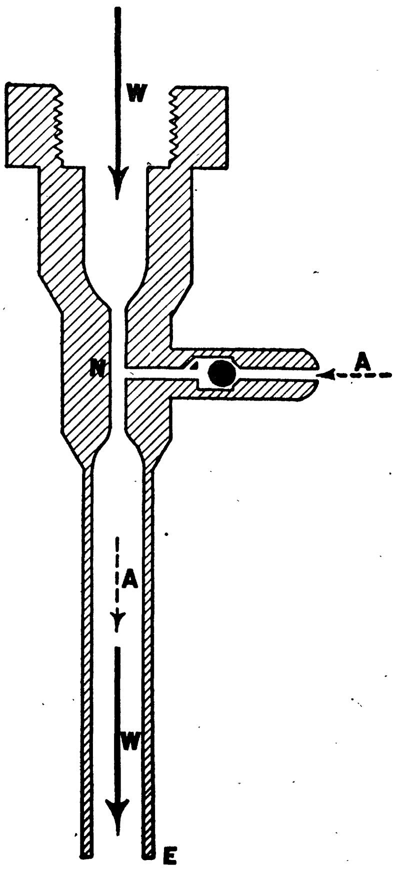

FIG. 3. A filter pump. Water rushing through the narrow channel at N reduces the pressure there and so air at A pushes in toward N and is carried out at E.

When a river flows around a curve as at (a), Fig. 4, one is inclined to think of the water just "washing out" the earth at (a) and letting it go at that. However, between the water flowing past (a) and the earth composing (a) there is a difference in velocity, and this produces a difference in pressure tending to pull the particles from (a) out into the stream where it is carried away by the onflowing water. Erosion is greatly accentuated by these forces due to Bernoulli, particularly where there is a light alluvial soil which has space for air in it. If the soil has great adhesive properties, this erosion is not so manifest as can be observed in certain southern soils where road cuts through the hills have their embankments cut quite steeply.

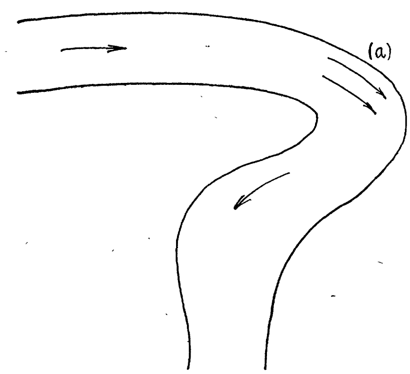

FIG. 4. Stream lines of flow of water in the river channel. Particles of earth are pulled out of the river bank at (a) or wherever water moves along the edge of the embankment.

The most outstanding example of this wear due to Bernoulli's principle is to be found on the surfaces of spillways to our large water power dams. This has given not a little trouble to the engineers. In some cases the spillways are carried through tunnels cut in solid rock which lead sidewise out around the ends of the dam. The water flowing along the surfaces of these tunnels have caused "cavitations" which have cut through the concrete lining and out into the rock surrounding the tunnel to depths of 25 feet or more. Even on the surfaces of open spillways there is a flow of water over a fixed surface and according to Bernoulli this means a difference in pressure which picks out the particles from the concrete surface at a rate not to be explained by ordinary friction of water flowing over concrete. The wear of steam valve-seats due to "wire drawing" of the steam is an analogous phenomenon. Bernoulli's theorem may serve as a basis for an explanation of the wear of cylinder linings caused by "blow by" of gases past the piston rings.

Returning once more to Fig. 1 we have a moving stream of gas particles which move with enormous velocities between the outer edges of the piston rings and the walls of the cylinder, a situation quite analogous to the illustration cited. This speed will be greatest at the top where the piston is at rest for an instant and where also the pressure driving the gas particles past the piston rings will be the greatest.

This in no way militates against the work done by A. G. Williams[3] on cylinder wear; he came to the conclusion that corrosion was the principal factor in cylinder wear. Corrosion goes on all along the surface of the cylinder exposed to the exploded gases, but the chemical effects produced by the CO_2 when it goes into solution with the water of combustion corrodes the surface of the cylinder and make the material of the surface of the cylinder just that much easier to pick off by the rapidly moving gas particles as they speed past the piston rings at the upper end of the stroke.

Shadow photographs of the rush of gases from the muzzle of a revolver show the gases escaping ahead of the projectile. This means that around the bullet, *i.e.*, between it and the inner wall of the barrel, gas is being forced at high speed in a fashion like that of the exploding gas around the piston and rings of the internal combustion engine. Here again the principle of Bernoulli operates to tear out the particles composing the inner wall of the barrel of the gun.

The "Big Bertha" started with an inner diameter of 8.2 inches to its detachable steel lining. After 66 shots had been fired, the inner diameter was 9.2 inches. If the principle of Bernoulli was effective the inner diameter of the lining should have been eroded more at the breech than at the muzzle. No data are available on this point, but Mr. P. A. Shepherd, an official of the J. Stevens Arms Company of Chicopee Falls, Mass., tells me that any rifle manufacturer knows that the erosion at the chamber end of a rifle barrel (throat erosion) is greater than at the muzzle. This substantiates the idea that the principle of Bernoulli is an important factor in this wear of a rifle barrel as well as that of an engine cylinder.

As a physicist I can see possibilities in this point of view, but there may be other phases to the problem which have not been considered and which might rule the Bernoulli concept completely out of court by the automotive engineers.

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ANOTHER VALUE OF A NATIONAL POLICY OF RESEARCH

MR. FRANK[1] has set down several excellent values that would accrue from having a national policy of research. However, he does not mention the greatest value of all, that of providing a rigorous concept of what is meant by the term research. As concepts of this sort need defining in terms of operational procedure, Mr. Frank's committee might well attempt to submit to the scientists of this country an outline of the basic steps and logical implications that underlie all modern research. This is no small undertaking, but is surely one that is basic to a national policy of research. The term research, if we are to continue to use it, should have a greater meaning than simply critical thinking or systematic examination.

Furthermore, if we are to urge research upon the members of society as a panacea for their ills we should be able to explain, very definitely and precisely, what constitutes research. If research is to be accepted as a fourth pillar of the state, at least the scientists, let alone the layman, should clearly understand how research is both related to and distinct from common-sense investigation. Modern usage of the term "research" is beginning to smack of faith-healing—a miraculous but mysterious process.

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SCIENTIFIC BOOKS

ELECTRONICS

An Introduction to Electronics. By RALPH G. HUDSON. x + 97 pp. New York: The Macmillan Company. 1945. $3.00.

IT seems to the present reviewer that this little book should serve a very useful purpose. It is written in extremely elementary language, but the author has succeeded in describing in relatively few words the essentials underlying the operational principles of a number of important electronic devices. The book will be useful to one who knows practically no physics because it will enable him to get a bird's-eye view of the operation of the essential devices. It will also be useful to the very advanced physicist because frequently he has not had time to acquaint himself with the devices which exist. A few words of elementary description is all that he needs to call the devices to his attention, and his own knowledge of physics will supply him with the remainder of the possibilities of understanding to a degree of detail, of course, much greater than is given in the book itself.

The book contains a well-balanced distribution between diagrammatical and pictorial material. Naturally it does not contain any appreciable amount of fundamental theoretical matter, but is essentially descriptive.

One does not demand very high logical accuracy in

[3] A. G. Williams, *Jour. Inst. Auto. Engrs.*, London, June, 1933, Vol. I.

[1] L. K. Frank, SCIENCE, 101: 433, 1945.