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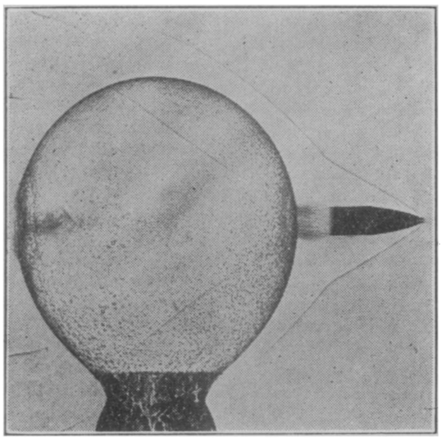
PHYSICS

Government Scientists Study Soap Bubbles



THE BULLET AND THE BUBBLE; photograph made in the Sound Laboratory of the U. S. Bureau of Standards by means of an electric spark, by Philip P. Quayle, showing a soap bubble through which a rifle bullet has been fired. The bullet has passed out of the bubble, but it still stands, with a hole in each side. The lines extending from the front of the bullet are sound waves

Have you ever studied a soap bubble? Perhaps when you were a child you were fond of playing with a dish of suds and a clay pipe, but the bubble is more than a toy, for grown up scientists at the U. S. Bureau of Standards in Washington have been studying them, even to the point of shooting bullets through them, and photographing them as they break.

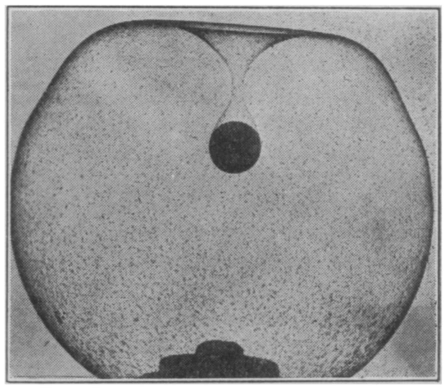
The photographing has been done by Dr. Philip P. Quayle, and uses light furnished by an electric spark, so that the bullet and half broken bubble are photographed as clearly as if they were at rest. And from these photographs it has been found that the bubble is not the simple thing that we used to imagine it, but some very complicated processes go on within its walls. Some of these are of considerable practical use, as in the mining industry, where they are used to separate precious metals from the ore.

Dr. Quayle's work has been in the sound laboratory of the Bureau, which is under the direction of Dr. Paul R. Heyl, whose studies along a different line in a subterranean vault under one of the Bureau's buildings have given a more accurate value of the mass of the earth.

The traditional material for bubbles is a soap solution. Every child knows that though bubbles may be formed in clear water they last but a fraction of a second. Soap, however, is not absolutely necessary for the production of a lasting bubble. The water of the sea is whipped by the wind and by its own motion into bubbles which may accumulate in heaps on the beach and last a long time. Carbonated beverages may produce a similar froth on a smaller scale. It appears to be a general rule that the formation of permament bubbles is possible only when the water contains organic matter of some kind, soap, glycerine, oils, vegetable extracts (as a seaweed in ocean water) or sugar and flavoring material, as in beverages. Quite small amounts of organic matter will impart to water film the requisite tenacity to produce a lasting bubble.

But the best of bubbles will not last forever, though some have been kept under glass for many hours. One of the most frequent causes of the death of a bubble is irritation by particles of dust, and when this is prevented the life of a bubble may be surprisingly long.

"When a bubble once gives way its complete disappearance is so rapid as to lead to the common impression that it is instantaneous," said Dr. Heyl. "The very rapid spark photographs taken of a breaking bubble by Dr. Quayle show that the bursting of a bubble is a progressive process, though a very rapid one. Photographs have been obtained of a bubble which has had a bullet fired through it. For a few millionths of a second (long enough to be photographed) the bubble stands as if in amazement with a hole in each side. The holes rapidly increase in size, the water film spraying off at the edges into fine drops, until in a thousandth of a second or so the bubble is gone.



STEEL BALL DROPPED INTO A SOAP BUBBLE. This photograph, made about a hundredth of a second after the ball first touched the bubble, shows that it has not yet begun to break, but extends down around the ball like an elastic membrane.

"One of the first things to catch the attention when a bubble has been successfully blown is the shimmering play of colors reflected from its surface. These colors, we notice, are formed somehow in the act of reflection of the colorless light of day from the surface of the bubble. It is possible, with a little practice, to detach the bubble from the pipe by which it was blown, and to catch it upon a piece of cloth, where it may remain for some time. If we closely examine the distribution of colors on such a quiet bubble we may be fortunate enough to see colored bands moving downward from the top of the bubble to the bottom. The north pole of the

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bubble seems to be the storehouse whence the bubble draws these colors in succession. And if we are exceptionally lucky we may see at the north pole, just before the bubble breaks, a black spot. It is as if the store of colors had been exhausted.

"Why should the colors stop coming? And why does the bubble become black rather than clear and transparent? Is there any causal connection between the appearance of this black spot and the immediately following disappearance of the bubble?

"During the brief life of the bubble as it stands upon the cloth the liquid of which it is composed flows slowly downward by gravity, the top of the bubble becoming thinner. This thinning out can be followed by the downward motion of the bands of color, for each particular color corresponds to a certain definite thickness (or rather thinness) of the bubble, and moves steadily downward as the film above it thins out. The black spot represents a place of such extreme thinness that it can no longer reflect light to the eye. All the light that falls upon it passes through.

"It may be perhaps a new idea that anything can be so thin that it cannot reflect light; but the study of thin films such as found in bubbles teaches us that light is not reflected strictly from the surface of bodies, but that it must penetrate a very little way into the substance of the body itself before it can be turned and sent back. Like a motor car, the beam of light requires a little room in which to turn. And if this necessary turning space is not to be found, the light will not be able to turn at all, but will pass through the film and out at the other side.

"This is true in the case of bodies ordinarily considered to be opaque, such as polished surfaces of metal. But even metals are transparent in

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News-Letter Features

Born over four years ago of the demand and interest of those individuals who had caught a glimpse of *Science Service's* news reports to newspapers, the SCIENCE NEWS-LETTER has since proved interesting to laymen, scientists, students, teachers and children.

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thin enough layers, as is evidenced by ordinary gold leaf.

"In penetrating the reflecting surface to this minute depth certain qualities characteristic of the reflecting material are impressed upon the light, so that by examining the reflected beam, even many miles away from the reflecting body, we can tell something about the material of the reflector. In fact certain scientists have attempted to gain by this means some idea of the different materials composing the surface of the moon. The moon shines by reflected sunlight, and the idea is that the light reflected from different areas of the moon's surface may, by its characteristically altered quality, betray the nature of the material which has reflected it.

"How thin is this black spot in a bubble, and what sets a limit to it? Why cannot a bubble thin out indefinitely? These questions lead to one of the most interesting things which a bubble can teach us. Water is made up of molecules, particles so inconceivably small that a soap bubble when freshly formed may be many molecules thick. But as the film thins out it is gradually reduced to a thickness of but a few molecules; and obviously this process cannot go on forever. The film cannot be less than one molecule thick. Any further thinning out is bound to break it.

"Now it is possible from the colors exhibited by thin films to obtain an idea of their thickness; and the black spot on the bubble cannot be thicker than the value indicated by the last color that made its appearance from this place. If the black spot be but one molecule thick, such a molecule cannot be greater in diameter than this critical thickness. This sets a superior limit to the size of a watery molecule, for if the black spot is two or three molecules thick, the molecules must be still less in size than this limit. Under no circumstances can they be greater.

"Other and different lines of experiment set an inferior limit to the size of a molecule. Jointly such results have led us to the conclusion that if a drop of water were to be magnified to the size of the earth the molecules of which it is composed would be in size between that of a baseball and a piece of small shot.

"Another curious and instructive thing about a bubble is its tendency to contract. If after a bubble be blown the mouth be removed from the pipe, the bubble will contract, even though the pipe be inverted so that

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DR. PAUL R. HEYL, head of the Sound Laboratory at the U. S. Bureau of Standards, in Washington, who tells of some of the wonders of the soap bubble. Dr. Heyl has also been engaged in a long series of researches to determine the exact force of gravity.

PHYSIOLOGY

Measure Dance Energy

Hostesses should lay in a heavy supply of refreshments, when they expect to entertain guests who like to display their Charleston proficiency. An account of an exhaustive survey of the energy consumed in dancing made by a group of Scandinavian scientists at the Physiological Institute of the University of Helsingfors, sets down in precise figures the number of calories used in different kinds of dances.

The waltz went to the bottom of the list with 3.99 calories used per hour per kilogram of body weight. The schottische, beloved of grandfather and grandmother, scored .02 of a point below the modern foxtrot, using 4.76 calories while the latter required 4.78. The polka, another institution of grandmother's day, needed 7.56 calories an hour, while the mazurka, evidently the fastest dance the learned Scandinavians could get anyone to practice for them, took 10.87 calories. or almost twice the amount of energy consumed by a stonecutter plying his trade.

It obviously remains for some American research worker to find out the number of calories that need to be supplied to devotees of the Charleston and the Black Bottom.

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CHEMISTRY

New Element in Pure Form

Rhenium, the chemical element whose discovery was recently announced by Doctors Walter and Ida Noddack, has now been obtained in pure form. The first discovery was based on the finding of the characteristic lines in the X-ray spectrum as detected by photographic plates, but now the Noddacks have succeeded in obtaining, after long and difficult refining processes, a small quantity of the substance itself. They describe it as a black powder of high melting-point, that unites readily with a number of other elements. In an atmosphere of pure oxygen it ignites, forming a white oxide. The quantity so far obtained is very minute, only two milligrams, or seven one-hundred-thousandths of an ounce, and the experimenters are now at work to elaborate more of it which will permit of exact quantitative chemical examination.

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ENGINEERING

Sweden Uses Peat

A new source of wealth has been found in the peat bogs of Sweden which heretofore have usually been regarded as so much waste land. Unlike the people of Ireland, the Swedish inhabitants have always had plenty of wood to use as household fuel, so that peat has only rarely been used for the purpose. On the other hand, Sweden lacks coal mines and in recent years there have been performed many experiments with peat as substitute and now the head of the Swedish peat industry, Lieutenant Herman Ekelund, declares that a peat powder can be produced by machinery, capable of creating any given degree of heat cheaper than coal, and in more convenient form. With peat as a fuel, he claims that iron ore can be reduced in small electrical ovens. Compared with charcoal, the peat powder costs but one half and if the iron thus produced is not of such high quality, it is better than if made with coke. With peat temperatures as high as 2,200 degrees centigrade have been attained.

An advantage of the new methods of exploiting the peat bogs is that the dugover area is not left flooded, but can be worked as farmland after suitable drainage. Where farming is not advantageous, as in the northern parts of Sweden, where it is too cold, forests can be planted and regular lumber crops raised.

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the bubble hangs downward. Sometimes this contraction may be so rapid and forcible that the air issuing from the stem of the pipe will blow out a small flame.

"A striking way of showing this contractile property is by the use of a glass funnel. If the funnel be submerged in the soap solution so as to wet it thoroughly on the inside, and then raised carefully by the stem a flat soap film may be seen stretching across the opening of the funnel. So strong is this tendency of the film to contract that it will run up the funnel, lifting its own weight in the process.

"Every liquid acts as though it were encased in a stretched elastic skin. Liquids in quantities such as are ordinarily handled do not show this property because so much of them is inside and so little on the outside, and the surface properties are masked by the properties characteristic of the inside. But a soap film is nearly all surface, and very little inside, and the contractile property of the surface becomes evident. This contractile property (surface tension is its scientific name) is responsible for a great many happenings in nature. It is the cause of the globular shape of a dew drop, of a rain drop, of water sprinkled on a dusty floor; it causes the ascent of oil in a lamp wick and is responsible for the absorbent property of a towel or of blotting paper. It governs the curious changes of shape in that wonderful little speck of protoplasm called the amoeba, and it is suspecting of having much to do with the contraction of a muscle."

But bubbles are useful in every-day life. "They play an important part in modern mining industry," said Dr. Heyl. "Often the valuable mineral is mixed with much rock from which it must be separated. Various methods of concentration are employed to effect this purpose. One which has been developed in comparatively recent years makes use of bubbles to this end. The mineral bearing rock is crushed to a powder and stirred up in water to which a very small amount of a special oil is added. The agitation of this mixture produces a froth of bubbles which rises to the surface, each of these little bubbles bearing attached to itself a particle of mineral, while the worthless rock is left at the bottom of the liquid. This froth is skimmed off, and a valuable concentrate obtained from it. This process is called flotation, and is one of the most important of modern developments in the art of mining.

"And the moral of all this is, as the Duchess might have remarked to Alice, that there is nothing in Nature so simple and commonplace as to be unworthy of our serious attention. Even the evanescent bubble leads us to such unexpected extremes as the winning of valuable minerals by the ton and the determining of the size of the molecules which constitute matter, and which we can never hope to see. The bubble is all things to all men; the toy of the child, the figure of speech of the poet, and the object of the careful study of the scientific man."

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Children do not develop color sense until about two years, a psychologist finds.

The U. S. Naval Observatory has been furnishing time for this country for over 92 years.

Fossils of mackerel have been found that date back to the Eocene period, perhaps 100 million years ago.

A Spanish vessel, laden with oils, that caught fire in New York burned 50 days before firemen finally conquered the flames.