

The Graphic Laboratory of Popular Science

The Element Fluorine Is Powerful in Action

By DR. THOMAS M. BECK

IN RECENT years it was noticed that children in certain communities in the great plains states showed a peculiar tendency toward a mottled brown discoloration on their teeth. This was not a result of lack of oral cleanliness, but was caused by a difference in the enamel itself. The ailment is hardly a serious menace to public health; in fact, some authorities claim that the mottled teeth are sounder than the white ones. They are not as beautiful, however, and so must be corrected.

It was found that the children so afflicted had during the first six years of their lives drunk from water supplies that contained a few parts in a million of sodium fluoride. This salt is absorbed into the body, where it reacts with the soluble calcium compounds in the blood to form calcium fluoride, an insoluble solid, which is then deposited in the bones and teeth. Methods have since been devised for reducing the sodium fluoride contents of water supplies to harmless levels.

Sodium fluoride is a compound of sodium and fluorine. Fluorine is the lightest of a group of four elements known as halogens. The other three, in order of increasing weight, are chlorine, bromine, and iodine. These elements are as similar as four brothers. Although their compounds are usually white, the free elements are distinctly colored. Fluorine is a yellow gas, chlorine is a green gas that condenses under pressure to give a green liquid, and iodine is a black solid

that gives off violet vapor when warmed.

The halogens are powerful oxidizing agents, fluorine the most powerful and iodine the least. They are all characterized by a peculiar disinfectantlike odor. They corrode metals and attack organic matter, descending in order of strength from fluorine to iodine. Their compounds with hydrogen (hydrofluoric, hydrochloric, hydrobromic, and hydriodic acids) are exceptionally strong acids.

It frequently happens in groups of similar elements such as the halogens that the lightest



Henri Moissan, celebrated French chemist, in his laboratory. It was Moissan who first was able to obtain the element fluorine for the study of its properties. He died in 1907.

element in a group is the most individualistic in its chemical behavior. Fluorine is no exception to this generalization. Most of its differences from the other three halogens, however, are of a type that can be appreciated only by chemists. But in one respect—its action on glass—it exhibits a unique behavior that not only astonishes the layman but is also of considerable industrial importance.

Glass is unaffected by the compounds of hydrogen with the other three halogens, but is quickly dissolved in hydrofluoric acid. The essential ingredient of glass, silica, reacts with the acid in an outwardly simple manner; silicon oxide (silica) and hydrogen fluoride (hydrofluoric acid) give hydrogen oxide (water) and silicon fluoride. The silicon fluoride is a gas and bubbles out of solution. Why hydrofluoric acid and none of the other three halogen acids behaves this way is a question that no one can answer yet.

Hydrofluoric acid is used as a reagent for analyzing glass and minerals containing silica. Still more important is its use in etching glass. The glass is first coated with wax, which is inert to hydrofluoric acid, and the wax is then removed in the places where etching is desired and the acid then applied.

Because of its destruction of glass and enamels, and because it is a strong acid when dissolved in water and therefore is corrosive to metals, the storage and handling of hydrofluoric acid once presented considerable difficulty. It was formerly prepared as a water solution, as are the other halogen acids, and was sold in wax bottles. At the present time it can be made on a large scale in a state of complete purity, in which condition it can be liquefied by a little pressure and is practically noncorrosive toward steel.

As a free element fluorine is perhaps the most violent chemical known. It vigorously combines with iron and the less noble metals in the cold and attacks even platinum at higher temperatures. It quickly reacts with glass, sulphur, and carbon and instantly destroys all organic matter with which it



(Margaret Bourke-White photo.)
Ingots of aluminum ready to be rolled. Fluorine compounds play an important role in the manufacture of aluminum.

Question Box

What element was known to exist for almost a century before it was discovered? Fluorine.

What chemical dissolves both glass and metals? Hydrofluoric acid.

What physical defect has been traced to the drinking of water containing traces of fluorine? A peculiar mottling of teeth.

Why was fluorine so difficult to prepare? It reacts with almost anything with which it comes in contact.

These and other interesting questions are discussed in detail by Dr. Beck in the accompanying article.

comes in contact. It even decomposes water, forming hydrofluoric acid and oxygen. Needless to say, it is not manufactured on a large scale.

Fluorine gets its name from one of its sources, fluorspar, a glassy, readily fusible mineral. The name fluorspar is in turn derived from the Latin word for flowing, because the rock is so easy to melt. Hydrofluoric acid was discovered about 1670 by the German alchemist Schwannhardt, who obtained it by mixing fluorspar and sulphuric acid. Because of analogies between compounds of both fluorine and chlorine, fluorine was

generally recognized as an element about 1800, although it was not isolated in an uncombined state for nearly a hundred years.

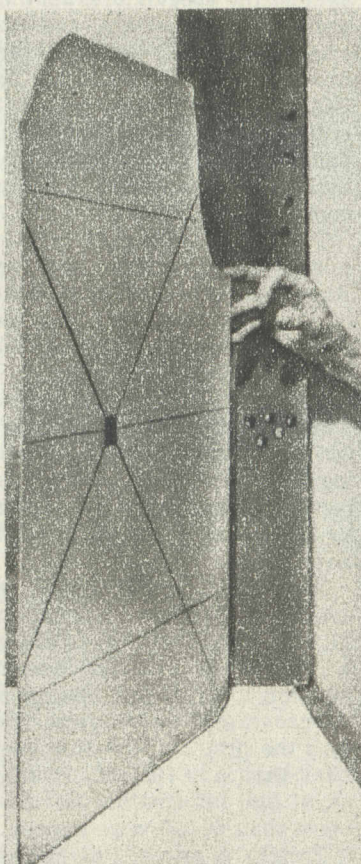
The difficulty in preparing free fluorine lay in its extreme reactivity. No chemical could be found that was powerful enough to displace it from its compounds. Theoretically it could be obtained by passing an electric current of sufficient voltage through a molten or dissolved fluorine compound. But the temperatures necessary to melt fluorine salts caused the fluorine immediately to react with the electrodes; or, if solutions were used at lower temperatures, the fluorine reacted with the solvent. Pure hydrofluoric acid, a liquid at moderately low temperature, could not be electrolyzed, since it does not conduct a current.

The problem was solved in 1890 by Henri Moissan, the chemist who discovered many of the reactions of the electric furnace. Moissan dissolved potassium fluoride in water-free hydrofluoric acid to make it conduct electricity and then electrolyzed it in an apparatus made of a platinum-iridium alloy. He was thus able to obtain small amounts of the element and to study its properties.

In addition to the use of hydrofluoric acid in etching glass, the compounds of fluorine have a number of other important applications. In the aluminum industry the metal is obtained by electrolyzing a fused mixture of aluminum oxide and cryolite, a naturally occurring aluminum fluoride with a characteristically low melting point.

The inorganic fluorine compounds are rather poisonous and have found extensive use as insecticides, particularly for moths. An interesting variation of this use is a type of organic fluorine compounds which, although colorless, have structures similar to dyes. Like dyes, these substances combine with fabrics and thus give a degree of moth protection that cannot be washed out.

Not all organic fluorides are poisons, however. A fluoride compound that has won considerable commercial importance in recent years is di-fluor-dichlor-methane, prepared by substituting fluorine for part of the chlorine in carbon tetrachloride. Unlike the mildly toxic parent compound, the fluorine derivative is quite harmless. It is a gas that can be condensed to a liquid with the help of a little pressure. In addition to being nontoxic it is noninflammable and noncorrosive and has found wide use as a refrigerant.



A plate of glass that has been etched with hydrofluoric acid. The square in the center and the cross lines were produced by coating those parts of the glass with wax. The rest of the surface then was etched in the frosted effect with the acid.

Mostly About Dogs

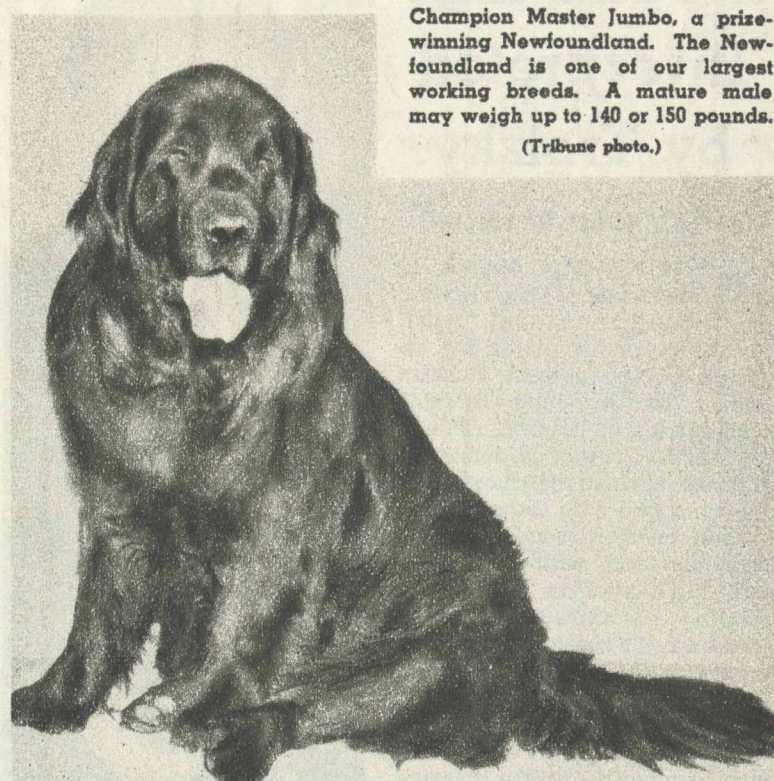
By BOB BECKER

Wide Choice of Big Dogs for Fancier

THE fancier who likes a large dog has a wide choice when he looks over the breeds recognized by the American Kennel club. Among the breeds that may be classed as large are working breeds and sporting hounds offering much variety in origin, coat, utility, and disposition.

The Newfoundland is one of our larger breeds that originated in North America, although there is reason to believe that its ancestors were brought to the American coast by European fishermen. A Newfoundland male in excellent condition may weigh up to 140 or 150 pounds, which easily takes him out of the lapdog class and puts him among our large-sized breeds.

As in the case with many breeds, the way the Newfoundland developed is a matter of conjecture. Some say he descended from the boarhound. But it is pretty generally agreed that the breed developed in Newfoundland, and it also is pretty certain not one but several breeds were involved in its evolution. Whatever his origin, the Newfoundland today is a courageous yet gentle, intelligent, and loyal heavyweight among dogs. He is a real working dog, as much at home in the water as on land. We have seen animals of the breed used as sled dogs

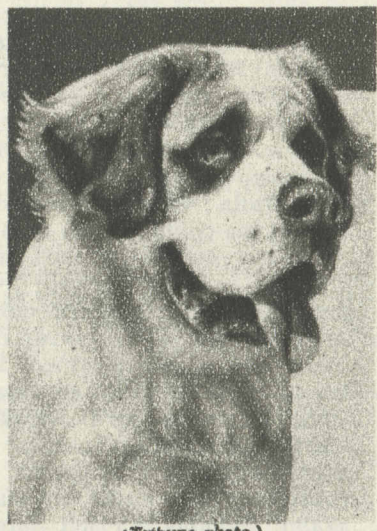


Champion Master Jumbo, a prize-winning Newfoundland. The Newfoundland is one of our largest working breeds. A mature male may weigh up to 140 or 150 pounds. (Tribune photo.)

The standard of the Irish wolfhound calls for a minimum of 120 pounds in weight and a height of 31 inches. The objective in breeding is a big dog of symmetrical lines, so you may see males weighing between 120 and 150 pounds.

The Scottish deerhound, a member of the sporting hound group, is another breed that hardly could be called medium sized or small. Males will run from 85 to 110 pounds. The standard of the breed calls for a male dog standing 30 to 32 inches at the shoulder.

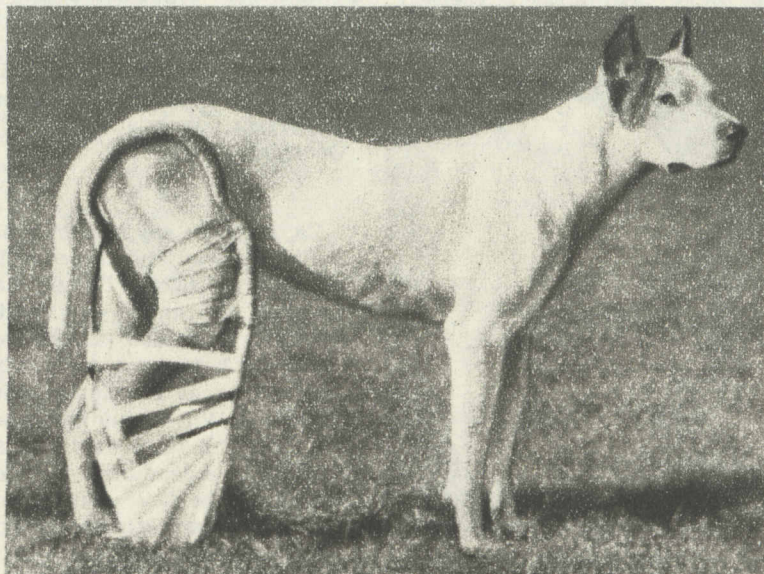
The bull mastiff, recognized in 1933 by the American Kennel club, is another breed that makes the scale tilt beyond the 100-pound point. This breed, 60 per cent mastiff and about 40 per cent bulldog, stands from 25 to 27 inches at the shoulder and weighs around 115 pounds. Few large dogs have held such unusual names as that possessed by the bull mastiff in the old days. It was sometimes called "the gamekeeper's night dog," which is a true indicator of the use to which these large dogs were put. The gamekeepers wanted a dog that would remain silent when poachers approached. They needed a dog that would attack on command. The bull mastiff was such a dog. He had the courage and weight to back up his work.



Head study of a prize-winning St. Bernard. The St. Bernard is an old and a large breed. (Tribune photo.)

in the moose country, where they quickly learned their duties in harness. Around the cabins we found them delightful companions—affectionate, eager to please, and good tempered.

Besides the Newfoundland, there are other large dogs for the person who is looking for size and weight. For example, both the Irish wolfhound and the Scottish deerhound are in the big class. The Irish wolfhound sometimes is referred to as the biggest dog in the world, but he has to win the title on height and length and not so much on weight, since there are other breeds which may weigh more than an adult male wolfhound. For example, a St. Bernard may weigh more than 200 pounds—even up to 220 pounds. This famous old breed calls to our mind the Hospice of St. Bernard, high in the Alps, and the way the monks of that hospice have been breeding St. Bernards for many years.



This 9-year-old Great Dane, Diana, is wearing a special crutch while recovering from a broken leg and an infected foot. Diana is owned by F. M. O'Brien, president of the village of Clarendon Hills.



Romanoff Sandra, a prize-winning Russian wolfhound. This breed originated in Europe and weighs from 75 to 100 pounds. (Tribune photo.)

to 125 pounds. The Russian wolfhound may weigh from 75 to 105 pounds, according to the standard.

DOG NOTES

The skilful and up-to-date veterinarian now is equipped to do unusual work in mending broken bones in dogs. With automobiles striking many dogs, the veterinarian often is called upon to take care of fractured bones. How the veterinarian may even provide a crutch for an injured dog is shown in the picture of the Great Dane on this page. This dog has had more than its share of hard luck. First it was badly frozen. When 3 years old it underwent a major surgical operation. At the age of 7 it lost six inches of its tail after it was caught in a car door. Then came a fractured leg. And now the animal wears a crutch until the fracture is mended.

Judging by the number of stray dogs that still are permitted to roam the streets and the woods and fields in the country, there are many owners who are failing in their responsibility to their pets and to their neighbors. As is often the case in dog ownership, the owner needs training and education with respect to his responsibilities more than a dog requires either or both.

A city man moving to the country should keep his dog under control, either on a wire run or in a kennel, taking it out for exercise only when some member of the family has the time to watch the dog. Automobiles are a menace to a dog in the country as well as in the city. Then there is a danger that a "gang" of other dogs may set upon the pet and kill it. A few weeks ago we saw a terrier that had been attacked by two dogs and nearly killed while it was running loose in the country. Still another danger to the dog allowed to contact roving strays is rabies. It's a known fact that the main source of rabies is the roaming stray dog.

For attractive offers of dogs, turn to the Dogs, Cats, Birds and Poultry column in the want ad section of today's Tribune.

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Prevention of skin trouble is worth a pound of cure. Don't wait for those raw spots to appear on your dog. The nourishing, New Red Heart Dog Biscuits, or Kibbled Red Heart, will enrich your dog's diet with Vitamins B and G, which are essential for a healthy skin and glossy coat.

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