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FIRE PROTECTION HISTORY-PART 212: 1898 ("CHEMICAL" FIRE EXTINGUISHERS)

By Richard Schulte

The second Annual Meeting of the National Fire Protection Association was held in Chicago in early June 1898. Among the topics of discussion at this meeting was the subject of "chemical" fire extinguishers. A paper on this subject was presented by Charles Hexamer. The following is the text of Mr. Hexamer's paper:

"***CHEMICAL FIRE EXTINGUISHERS.***
C. A. HEXAMER.

Two thousand years ago the ancient Greeks, in order that the burning arrows of their Asiatic enemies might not consume their wooden defences, used alum to coat all exposed woodwork, and prepared alum solutions for fire extinguishing purposes. From that time to the present day the use of chemicals for fire extinguishing purposes has received considerable attention.

During the great fire in London in 1666, it was noticed that on exploding a large quantity of gun powder to destroy a building in the path of the fire, all flames in the immediate vicinity were extinguished. Bombs, containing inflammable chemicals known to give off stifling gases, provided with an igniting fuse, and intended to be thrown into a burning building, were used early in the 18th century.

In 1715 an extinguishing apparatus was used consisting of a cask of water into which a can of gunpowder was suspended in such a manner that on placing the apparatus in a burning room and exploding the gunpowder by means of a fuse the water would be thrown in all directions, and together with the dense gunpowder smoke would extinguish the flames. Hollow clay or glass balls filled with finely powdered alum, and containing a charge of gunpowder arranged to be ignited by a fuse, and intended to be thrown into the fire, were used as early as 1770.

From early in the present century when the fire extinguishing qualities of various chemicals became better known, up to the present day, a large number of so-called fire extinguishing solutions and compounds were from time to time brought to the attention of those interested in extinguishing fires. The claims made by the various inventors and manufacturers of such devices seem to be stereotyped, those nearly one hundred years old reading the same as those of today. The description of fire tests made to demonstrate the value of the earlier devices vary but little from those reported in the newspapers of the present time.

The early inventors also knew that mysterious and secret compounds for fire extinguishing purposes would be bought by the general public at many times their intrensic [intrinsic] *value. While hundreds of compounds and devices have been " invented" (?) few, if any, have succeeded in demonstrating their value, and of obtaining a foothold among the fire extinguishing apparatus of our fire departments.*

It may be well at this point to consider the term "invented" as applying to this class of chemical extinguishers. As the chemical salts and gases with fire extinguishing properties are well known, the "invention" of a new chemical with these properties is out of the question. The "inventor" of fire extinguishing powders or solutions is restricted to compounding mixtures from the following list of chemicals, whose properties are well known, viz:

Alum,
Soda,
Borax,
Hyposulphite of Soda,
Silicate of Soda (water glass),
Chloride of Lime,
Tungstate of Soda,
Chloride of Tin,
Sulphate of Ammonia,
Chloride of Ammonia,
Sulphate of Soda,
Nitrite of Soda,
Chloride of Sodium (common salt),
Potash,
Bicarbonate of Soda, and
Ammonia.

The process of inventing a chemical fire extinguishing compound is, therefore, the question of a short time. As an example of this class of chemical fire extinguishers, I will ask you to recall the advent of the "Hand Grenade." The millennium had arrived; no more conflagrations were possible. Fire tests such as described further on, were made in every city and village; thousands of glass bottles filled with an inexpensive saline solution were sold at many times their value; the papers were full of cases of fires extinguished by hand grenades, etc., etc. The claim that a substance had at last been found, which, thrown into a fire at its incipiency, generated a gas and promptly extinguished the flames, seemed to be substantiated. The burning of a warehouse containing a very large number of hand grenades on storage in this city, however, demonstrated very forcibly that the extinguishing gas supposed to be generated by heat, did not generate.

It is not the object of this paper to discuss in detail the value of the various chemicals above mentioned; but to describe briefly the principle and construction of the only chemical fire extinguisher which has won a permanent place among the apparatus used by organized fire fighters throughout the world, namely, the Carbonic Acid Gas Extinguisher. The first carbonic gas machine was constructed by Charlier & Vignon in Paris in 1864, and excepting that tartaric acid powder used to liberate the carbonic acid gas from the bicarbonate of soda solution was soon replaced by sulphuric acid and the construction, providing for the liberation of the carbonic acid gas on closing the cylinder and the maintenance of a constant gas pressure, was soon discarded, there has been no change in the principle of this class of apparatus.

The apparatus is well known to you all. It consists of a cylinder, usually of copper, which, as the pressure of the gas generated therein reaches about 125 pounds per square inch, and which under certain conditions may largely exceed this, for safety must be strong enough to stand from 300 to 500 pounds pressure to the square inch. The cylinder is closed by a screw cap, and provided with an outlet to which a short piece of hose is attached. A short metal nozzle, usually of lead or an alloy of lead, is attached to the hose. A stop-cock to shut off the chemical fluid may, or may not, be used. The chemicals used are bicarbonate of soda dissolved in water of sufficient quantity to fill the cylinder, and sulphuric acid, which latter is contained in a glass bottle inside the machine, so arranged that when to be used the bottle is either reversed or broken, discharging the acid into the soda solution, generating carbonic acid gas.

The various extinguishers now in use differ principally in the method of storing the sulphuric acid, and in the method of mixing the acid with the soda solution. Without going into details as to the mechanical construction, I will briefly describe the simple chemical reaction which takes place in all extinguishers of this class.

When sulphuric acid is mixed with bicarbonate of soda dissolved in water, the sulphuric acid at once combines with the soda of the bicarbonate of soda, forming sulphate of soda and liberating carbonic acid gas in great volume. The value of the apparatus is due to this chemical action. Both the soda solution and carbonic acid gas are of value as extinguishing agents, although I believe that except in cases of very close application to the fire, or in confined spaces, the carbonic acid gas is valuable more as a propelling agent for the soda solution than as an extinguishing agent.

The proportion of the chemicals are so arranged that the amount of bicarbonate of soda is largely in excess of the amount necessary to take up the quantity of sulphuric acid used. This is done that the solution ejected from the extinguisher may be alkaline and prevent free acid from doing damage. Secondly, to make the resulting soda solution as strong as possible.

As above stated, I believe that the soda solution in most instances is of more value as an extinguishing agent than the carbonic acid gas. I base this assertion on the fact that, when the stream from a chemical extinguisher is thrown on the fire from a distance, the larger quantity of the carbonic acid gas is dissipated.

As carbonic acid gas acts solely by exclusion of the air necessary to support flame, and as the proportion of carbonic acid gas necessary to render the air in a certain space a non-supporter of flame is about ten per cent, in large open rooms, or in the open air where confining the gases is impossible, carbonic acid gas–excepting it be used in exceedingly large quantities–is of little avail.

The value of the carbonic acid gas extinguisher depends largely on the fact that the soda salts are very soluble, and that a saturated solution of it when thrown on the fire at once coats the burning substance with a crust of incombustible soda salts, thereby preventing the spread of the fire. It is due to this fact that chemical fire buckets, syringes, and the tin tube extinguishers have in some cases been of value, as a soda solution of some kind is usually the chemical this class of extinguishers contain. It is safe to assume that the claim made that this latter class of chemical extinguishers extinguished flames by means of a gas generated from the chemicals they may contain, when thrown on the fire, is not entirely borne out by the fact. I do not wish to be understood to say that a gas which does not support combustion cannot be used to put out a fire under certain conditions; but the conditions in actual practice do not warrant the claim made for the so-called chemical extinguisher. The value of extinguishers of this class is further reduced by the fact that, in order to be at all effective, it is necessary that they be used on the flame at close quarters, which in most fires is impossible on account of smoke.

Chemical extinguishers without carbonic acid gas, and using compressed air as a propelling force, have, as you know, been on the market for some time. The effectiveness of this class of extinguishers is, however, reduced by the fact that it appears to be difficult to construct an apparatus which will permanently hold air under pressure.

In 1881 a patent was issued to a man named Raydt for an apparatus for extinguishing fire, consisting of a large cylinder for water and a smaller one for liquefied carbonic acid gas. By opening a stop-cock the liquefied gas was introduced into the water cylinder so that carbonated water at great pressure was at once available. While this apparatus was of good extinguishing effect, it never came into general use. Stationary cylinders of liquefied carbonic acid gas should, however, be of value for extinguishing fires in confined spaces containing inflammable substances. For instance, coal bunkers of vessels, holds of vessels, cotton warerooms, etc., etc. Oil tanks could be very successfully protected by a device arranged to discharge carbonic acid gas over the surface of the burning oil.

Returning to the question of extinguishing fires by means of gases generated from chemicals thrown into the flames, I am of the opinion that this claim is largely due to the fact that so-called fire tests of fire extinguishers are generally arranged to prove this claim. You are all familiar with the stereotyped test of this kind; a large wooden box, carefully placed with reference to the direction of the wind at time of test, is partly filled with strips of wood, excelsior, and other inflammable material treated to a liberal allowance of coal oil, turpentine or tar. The application of the liquid from the extinguisher being tested is made to the base of the burning mass, apparently that the gas generated from the chemicals may rise and extinguish the flame. Some gas, if the heat is great, is undoubtedly liberated and has some effect on the flames. The fire, however, is usually extinguished by the coating of the burning substance with a soda salt, thereby preventing the generation of combustible gases.

It is found that in such tests the oil used after having the desired effect of creating a very large and fierce flame has been entirely consumed. I recall a test of a chemical extinguisher where the regulation test was made as follows: A large piano box with one side removed and set on edge was partly filled with strips of wood and excelsior, liberally treated with coal oil, the upper portion of the box was painted with a tarry mixture; when ignited, the flame shot up 20 feet or more. With one application of the extinguisher the flame was extinguished, the oil and tarry paint having been entirely consumed, and the wood only slightly charred.

In order to show the value of the extinguisher being tested, the inspector of the local underwriters' association present arranged a test as follows: A wooden box constructed to resemble a wardrobe in a dwelling, but without doors, was filled with old clothing, both cotton and woolen, suspended from a shelf, additional clothing being piled on the shelf. No oil or other inflammable matter was used. When the clothing was ignited and the fire well under way, the expert of the extinguishing company present was directed to attack the fire. About a dozen extinguishers were used at very close quarters without having a very decided effect on the fire, which was not extinguished until the clothing had been consumed. While one extinguisher was sufficient to extinguish a fire with flame nearly 20 feet high, the attempt to extinguish burning clothing in the open air where it was possible to fight the fire at close quarters proved a failure. If the burning clothing had been in a room with no chance for the stifling smoke to escape, the result would necessarily have been even a greater failure.

It has been claimed by some that ordinarily a fire extinguisher containing chemicals in solution is valuable only to the extent of the water contained therein. A recent test of a chemical attachment to fire buckets seems to substantiate this claim.

In all large cities were carbonic acid gas extinguishers are a part of the regular equipment of the fire department, either as portable extinguishers in connection with patrol wagon or hook and ladder companies, or as chemical engines, the results achieved are very gratifying. In Philadelphia during the years 1896 and 1897 fully 25 per cent of all fires were extinguished by chemical engines. In this city the percentage is even larger. In suburban towns, villages, and isolated country properties a chemical extinguisher, either portable or on wheels, is of greater value than all other apparatus. In answer to queries sent to chiefs of fire departments throughout the United States, it is shown that in various cities from 25 per cent to 80 per cent of all fires were extinguished by carbonic acid gas without the use of water.

Now that automatic fire alarms are coming more generally into use, both in cities reporting to a central station and in isolated risks reporting to the house of the manager or superintendent, so that a fire can be attacked in a very short time after starting, the carbonic acid gas extinguisher, quickly handled, effective in its work and causing the minimum damage to property by reason of water used on the fire, is of the greatest value.

Unfortunately, there is a limit to the effectiveness of chemical fire engines when called upon for use in our modern "sky scrapers." A stream from the chemical engine on the pavement can only be carried to a height of 130 to 150 feet. It is, therefore, desirable to provide stationary or portable extinguishers for use in the upper stories of our high buildings. Stationary carbonic gas engines, so arranged that they are available at any story, have come into use, and for high office buildings are undoubtedly of great value.

An automatic carbonic acid gas sprinkling device has also been proposed but has not as yet been introduced into practical use. The same may be said regarding a device providing for the discharge of both carbonic acid gas and ammonia gas stored in liquefied state, and released automatically in case of fire. While experiments have been made with these devices, they have not had the actual fire test.

It has also been suggested that the stream from the ordinary steam fire engine be charged with a fire extinguishing salt on its way to the fire, and apparatus for this purpose have been constructed and tested, but have not as yet been perfected.

A carbonic acid gas machine arranged to discharge dry carbonic acid gas or a chemical stream, and intended for use on electrical fires, when it is desirable to extinguish the fire without the use of water, has recently been brought to my attention.

Underwriter associations, with their usual conservative and careful consideration of new devices, have been very slow in recognizing the value of the carbonic acid gas machine, preferring to make allowances for water buckets; few associations taking action and recognizing one three-gallon extinguisher as the equivalent of six water buckets. This attitude of the underwriter is largely due to the usual apathy of the general property owner to the care of fire extinguishing devices, after they have had the desired effect on his rate of insurance. A chemical fire extinguisher to be of value must be periodically examined to determine whether it is in working order, and at least once in every six months should be discharged and recharged. The cost of recharging a three gallon extinguisher is about seven cents. Discharging the extinguisher at stated intervals also familiarizes the employees with its use.

Chemical fire buckets, being ordinary fire buckets filled with water in which one or more of the chemicals mentioned are dissolved and provided with a paraffined paper or sheet lead cover, easily broken, have been in use for some time in factories and other risks and have given fairly satisfactory results, as they could not be used for other purposes than for extinguishing fire, and as they needed less attention than ordinary buckets.

In practice, I have frequently recommended the use of barrels of water in which a quantity of lime had been slacked, and in which a considerable quantity of common salt had been dissolved, as a very efficient fire extinguishing liquid for use with the ordinary fire bucket. This solution does not readily freeze in winter or foul in summer, and can therefore be kept for a long time.

What to consider a satisfactory fire test of a chemical extinguisher is difficult to decide. The regulation tests known to all are of little or no value, as they present but one kind of fire, and that, the one most easily extinguished. The only practical test I can recommend is to place the extinguisher to be tested in the hands of experienced firemen connected with some city fire department for general use. If, after a trial of six months or more the extinguisher has shown good results, not only as to fire extinguishing qualities, but also as to general conditions, such as deterioration of contents, corrosion of vessel containing the extinguishing fluid, etc., it may merit more careful consideration by the fire insurance engineer. The question of preparing a specification for a standard chemical fire extinguisher is one well worth a special committee of this Association. Suffice it to say that, in my estimation, such an apparatus must be a carbonic gas extinguisher."

The paper on “chemical” fire extinguishing agents presented at the second Annual Meeting of the National Fire Protection Association represents the state-of-the-art of fire protection circa 1898. The list of fire extinguishing agents included in the paper does not include halogenated compounds, however, the use of carbon tetrachloride as a fire extinguishing agent would soon be “discovered”.

Although the concepts presented in Mr. Hexamer’s paper appear primitive today, it is well worth noting that it was understood, at least by some, that the use of carbon dioxide (“carbonic acid gas”) as an extinguishing agent was based upon the ability of CO_2 to reduce the concentration of oxygen in the air, thus reducing the rate of combustion.

The reference to “chemical” engines in this paper is also worth noting. The “chemical” engine used in the late 1800's and the early 1900's has been replaced by the use of foaming agents and “light water”.

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