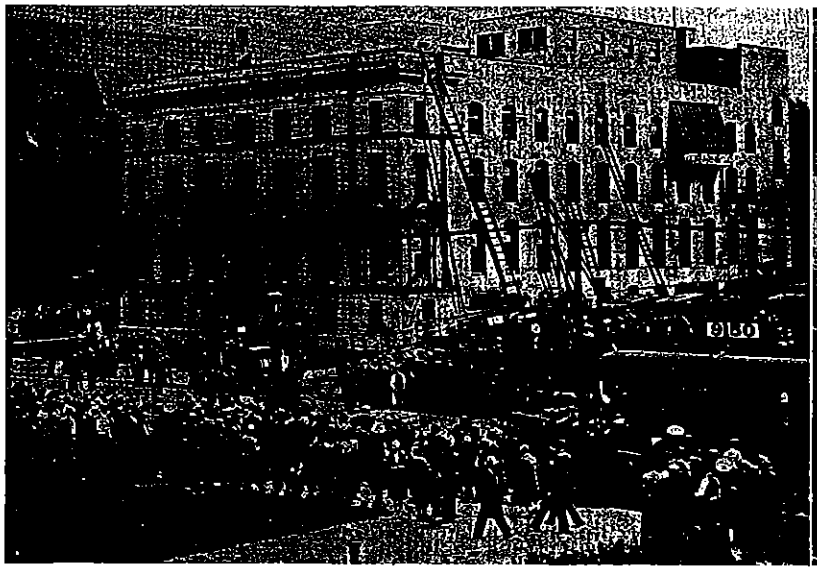
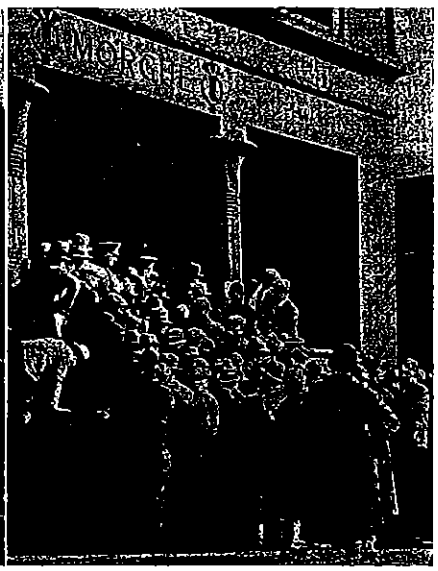
The Cleveland Clinic Fire

May 15, 1929

122 Dead in Nitrocellulose X-Ray Film Fire



International. Scene of the disaster.



International. The tragic aftermath.

One hundred and twenty-two people died as a result of a fire originating in nitrocellulose X-ray films in one of the buildings of the Cleveland Clinic Foundation, Cleveland, Ohio, on May 15, 1929. The films were stored in the basement. When fire occurred the noxious smoke and gases from the films quickly spread throughout the building. The brown fumes meant death to those who inhaled them. While a hospital, the majority of the people in this building were adults able to walk—not bed patients. The large loss of life thus indicates the almost instantaneous character of the disaster.

The properties of nitrocellulose film are a matter of common knowledge. Previous fires have given sufficiently gruesome evidence of the extreme flammability of the film, and the noxious character of the gases given off when it burns. Experiments were made years ago to ascertain how it might be safely stored. The National Fire Protection Association's Committee on Hazardous Chemicals and Explosives made recommendations for its safe storage and handling that were published by the National Board of Fire Underwriters in 1925 and have been widely circulated. Instead of being stored in a vault, protected by automatic sprinklers and provided with a vent to carry off fumes in case of fire, the film in the Cleveland Clinic was stored in an old coal bin, exposed to several potential sources of ignition, without automatic sprinkler protection, and with direct opening to a pipe tunnel and shafts that furnished a natural path of travel for the fumes to every room in the building. The most diabolical cunning could scarcely have devised an arrangement more surely calculated to spread death throughout the building.

For a number of years there has been available "safety" film, composed of cellulose acetate, and having no more fire hazard than paper or cardboard. This film has the same photographic properties as the dangerous nitrate film, and has for some time been used for X-ray work in hospitals where the management has appreciated its responsibilities and realized that the human element might nullify all mechanical precautions taken to safeguard nitrate film storage.

It is inconceivable that the conditions responsible for the Cleveland hospital disaster could have been permitted to exist even for a single day had the management or the inspection authorities appreciated the hazard. The city manager's official investigation has not yet been completed and the coroner's inquest has been held in part behind closed doors. These investigations may perhaps establish responsibility.

The physical facts are well established. There was a large quantity of nitrocellulose X-ray film in the basement. It was stored in obvious violation of proper precautions for the keeping of this material of known dangerous properties. One hundred and twenty-two people were killed. It is futile to speculate on the responsibility of the management or the lack of an intelligent public opinion to compel the correction of such dangerous conditions. We should turn to the more constructive task of seeing that the lessons of this disaster are heeded, and that hospitals throughout the world from now on use only the "safety" X-ray film and take proper precautions for the storage of any existing nitrocellulose film that must be retained. Likewise thought should be given to other fire dangers, of which fire prevention authorities have given warning, that carry the possibility of similar fire disasters which can be avoided through simple fire prevention precautions.

National Fire Protection Association (INTERNATIONAL), **60 Batterymarch Street, Boston, Mass., U. S. A.**

June 1, 1929.
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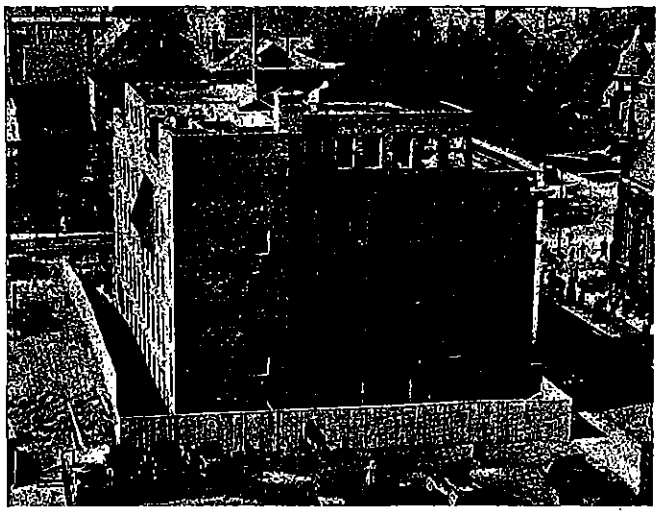
N. E. A. Service.

Frantic rescue work. Most of those rescued died later.



Rear of the building. Fire started in the left corner of basement at this end and spread up stairway.

THE CLEVELAND CLINIC

The clinic was a private institution organized, it is understood, by Dr. George W. Crile, a surgeon and physician of considerable note. With him were associated other specialists who made use of the clinic for diagnosis and similar work. In this, much X-ray work was done.

When the fire occurred at 11:30 A.M., the clinic was at its busiest. About 225 persons were in the building. The fire came when some three tons of X-ray films stored in the basement decomposed and ignited. The fumes spread through a back stairway and pipe openings leading to wash basins in most of the rooms of the building, being forced through the structure, as if under pressure, by several flashes or explosions. Only about 100 got out alive.

As the fire broke out conditions were such as have only been seen in war. A fierce fire in the basement and roaring up the rear stairway—two or more explosions—deadly brownish gas permeating the building—inside the building people collapsing on the bodies of those already dead.

Someone telephoned the fire department. On its arrival the building was encompassed by a pall of vapor, the breathing of which caused the death of several persons not in the building, one a woman in a passing street car. The explosion which blew off the skylight vented the building and allowed the placing of ladders for rescue work.

Many of the 122 who lost their lives were killed outright, others escaped from the building only to die later. A few who had been gassed apparently suffered no immediate ill effects, but subsequently collapsed and died. Early estimates of life loss were low, as no one seemed willing to credit the extent of the tragedy. Seven doctors were among the fatalities, five of them associates of Dr. Crile.

The city morgue was taxed to capacity to care for the many bodies, some of which were not identified for several days.

The Building

The clinic building is one of three belonging to the Cleveland Clinic Foundation, the others (not involved in the fire) being a hospital and a laboratory.

The building is of fire-resistive construction, four stories and basement, 122 by 74 feet. There are no automatic sprinklers. The construction consists of reinforced concrete floors and walls, the outside walls being brick faced. Partitions are of hollow tile. The fourth floor ceiling was of light metal lath and plaster.

In the center of the building and extending through the three upper floors was a large open light well about 32 x 40 feet with a ceiling of plain glass in wooden frames. Between the concrete roof and the ceiling of the fourth floor is a 4-foot attic space extending over the whole area of the building. Above the glass ceiling of the light well is a large skylight of wired glass in metal sash.

Around the light well on each floor are small examining rooms, each equipped with a wash basin. Between each two rooms is a small vertical shaft for water and steam pipes, into which medicine cabinets are loosely countersunk. These shafts were about 12 x 24 inches and extended from the basement to the attic space.

The first story contains offices, laboratories and X-ray rooms. The room used for the filing of current X-ray films in this floor was not involved in the fire, but the room was unsprinklered and the films were stored in ordinary filing cabinets, with no provision for venting gases in case of fire.

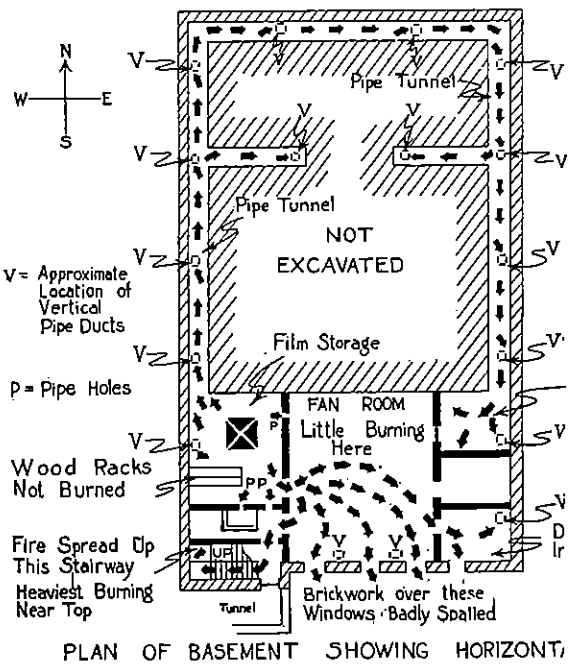
The basement extends only about one-third of the length of the building in the rear and contains the heating equipment, electric switchboard, drug supply rooms and a former coal room, the latter used at the time of the fire for the storage of pipe fittings, clinical records and X-ray film. A pipe tunnel 4 feet wide and 6 feet high extended completely around the unexcavated part of the basement.

The Coal Room

The room which had been designed as a coal bin had been converted for storage. It was a brick enclosure 19 x 24½ feet, a little over 9 feet high, and without windows. The pipe tunnel extending around the basement opens directly into a corner of this room.

Nitrocellulose X-ray film, size 14 x 17 inches, in paper envelopes, was stored in this

Diagram Showing How



PLAN OF BASEMENT SHOWING HORIZONTAL SPREAD OF FUMES AND FIRE

ternational.

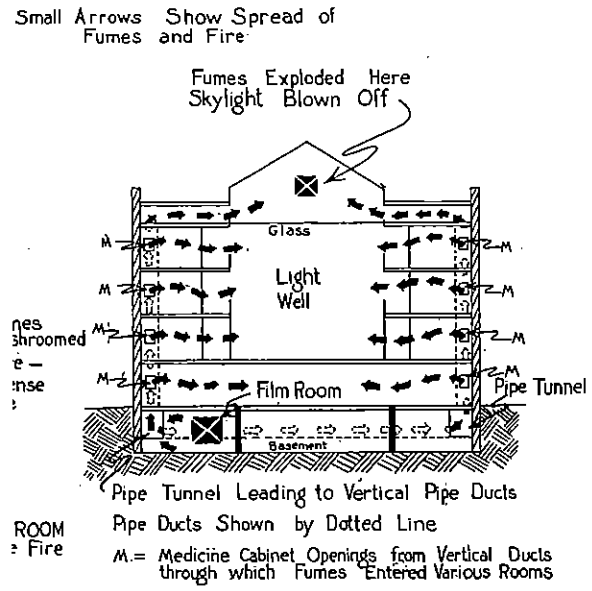
Where the fire started. Note electric light bulb and steam pipes.

Skylight blown off by explosion. Lower sash undamaged.

room, mostly on wooden shelves, but some in steel filing cases. Estimates place the amount present between 3 and 4 tons. In spite of this tremendous quantity, the room was not sprinklered nor were vents to the outside provided. A disused coal chute which might have acted as a vent was closed on the outside by a heavy iron door cover and by a wooden shutter on the inside. A doorway connecting with the heater room was equipped with a fire door.

Lighting was by ordinary electric bulbs on pendant cords. A 4-inch steam line bringing steam, at a reported pressure of from 45 to 65 pounds per square inch, from the near-by hospital passes overhead through the coal room. This pipe was about a foot above the film storage shelves and a vertical section passed within a few inches of the shelves. Where this and several other pipes passed through the walls, holes had been broken through, but had not been subsequently bricked up around the pipes.

'umes and Fire Spread



SECTION SHOWING HOW FUMES SPREAD VERTICALLY THROUGH BUILDING

What Happened

Wednesday morning, May 15th, a steamfitter arrived at the Clinic to repair a leak reported in a steam pipe in the film storage room. At 8:45 A.M. he entered the room and, hearing steam escaping, proceeded to unwrap the magnesia covering from a 4-inch main steam supply pipe to locate the leak. This pipe is said to be the one located directly over or near the film storage racks.

The steamfitter could find no leak, but the room was said to be extremely hot.

Two hours later this workman returned on a second call and found the room filled with steam. He went to the hospital building to have the steam supply shut off. This the engineer did.

Twenty minutes later, or at about 11:15 A.M., when the steamfitter returned again, he heard a "sputtering hiss" and saw a cloud of yellow smoke 4 or 5 feet in diameter at the ceiling of the film room. Obtaining a 2½-gallon soda and acid type extinguisher near by, he directed the stream with no apparent effect at what he supposed was a fire. Fumes poured forth faster and faster. Being nearly overcome and having exhausted the extinguisher, he had just reached the door of the film room when an explosion occurred. The fire door remained open. He managed to reach a window and was blown through it by a second explosion.

How Fire Started

It is obvious that the fire came from the decomposition of the nitrocellulose film. Pyroxylin compounds like nitrocellulose film are chemically unstable at elevated temperatures and decompose at temperatures as low as 300° F. This decomposition generates further heat and liberates carbon monoxide, various oxides of nitrogen and other gases which are both poisonous and highly explosive. Exactly how the decomposition was induced is not yet definitely known. The following are possibilities arranged roughly in the order of their probability.

(a) Electric Light Bulb. About where the steamfitter was working was a pendant bulb said to be 100 watts capacity. The cord was draped around a disused steam main, and the bulb hung just above the top of a shelf used for film storage. Had there been several envelopes of film on this shelf the bulb would have been resting directly on the film. Enough heat would thus have been available to start decomposition of the film.

A bulb on an extension cord was provided and habitually used by the X-ray technician who filed the films. This bulb may have been used by the steamfitter and left in contact with some of the films.

(b) Steam Pipe. Although there was no leak found, there was certainly steam escaping, and a jet impinging on a film may have induced decomposition. The heat from the steam pipes, which with steam at 65 pounds pressure would have been at about 312° F., would have been ample to start the decomposition. The steam pipe passed so close to the film storage shelves at one point that a bare fitting was within a few inches.

(c) Matches or Smoking. The newspapers reported that an inspection agency had found a package of cigarettes in the coal room a few weeks before the fire. A discarded match, cigarette or tobacco ash is at least a possible source of ignition.

Ignition of the gases, causing the several explosions, may have resulted from the heat generated by the decomposition of the film. There was an automatic gas water heater just outside the room in the basement, the pilot light of which is believed to have been lighted, and which is a possible source of ignition.

Spread of Fumes

During the minute or so the steamfitter was using the extinguisher on the fire the fumes filled the coal room, driving him out. The two puffs or "explosions" apparently

forced these fumes at considerable pressure into the pipe tunnel and up the pipe ducts. The fumes found an outlet into practically every room of the building from around the medicine cabinets. The gas could be readily traced through the building, as it left a thick brown deposit where it condensed on cold surfaces.

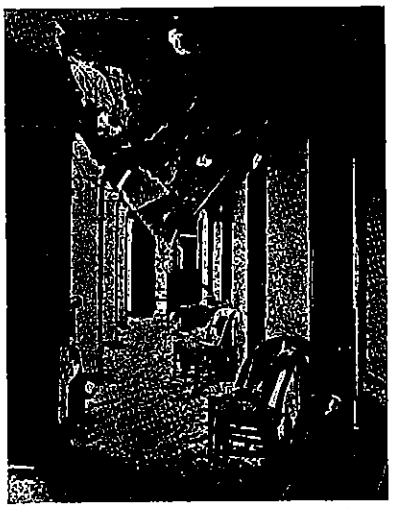
The gases passed through the pipe ducts to the attic space, where, some ten minutes after the fire started, they ignited, causing an explosion which blew down the light metal lath and plaster ceilings of many of the fourth floor rooms and blew off the skylight of wired glass in metal sash. Strangely enough, the plain glass panes in the ceiling over the light well were scarcely damaged, although the frames were displaced.

In the film storage room the wood film racks were consumed, as was practically all the film. Other wooden shelves used for storing pipe fittings were not burned, showing that there was relatively little fire in the room itself. Probably the first explosion largely consumed the air in the room.

The fumes, however, got out through the door of the room, as the arrangement of weights and pulleys designed to close the door failed to function, although the fusible link operated. They also found egress through the many pipe holes in the walls and ceiling. The fumes filled the disused heater room and passed up the rear stairway, the doors to which were open.

There was little burning in the heater room, the gases for the most part not igniting until they reached the outside air. There they burned fiercely, as the brickwork outside above the heater room windows was badly spalled. The fire in the drug room off the heater room, where the fumes found air from a window, was intense.

Fire was also intense in the other storage room connecting with the basement pipe tunnel. The fumes, forced around through the tunnel, mushroomed there and ignited. The contents of another small storage room on the same side of the basement were practically undamaged.



Ceiling of the fourth floor blown down by the explosion in the attic space. At the left is the light court and at the right the doors to examining rooms.

The fumes spreading up the back stair ignited as they reached air. The fire damage to wood hand rails and baseboards was progressively greater as it went up this stairway and entered the third story corridor. Wooden door frames as far as 30 feet from the stairway were burned on the third floor.

The fire very largely burned itself out. The fire department's facilities were taxed by rescue work, but five streams were laid and the little fire remaining after the explosions was extinguished.

The Loss of Life

Some 225 persons were in the building at the time of the fire. Most of these were in the numerous examining and consulting rooms on the various floors. Some were in the waiting room in the central court.

The deadly fumes, forced through the pipe openings to every part of the building, caught many persons unaware. Several doctors and nurses collapsed at their desks. Others, aware of the gases at first by their irritating odors, gasped and collapsed as they sought air. Others could struggle to a window, a door or to a stairway before their lives were snuffed out. Firemen entering the front stair tower from the roof found 16 bodies strewn at intervals along that stair. Probably half of the persons present died an almost instant death.

Others were able to get out or were rescued by firemen and policemen, but all who had inhaled the fumes in any quantity died, some soon after and others not for several days.

While the exact cause of the deaths is uncertain, most of them resulted apparently from the carbon monoxide and nitrogen peroxide from the burning film. Carbon monoxide kills without warning. Nitrogen peroxide tends to form nitric acid in the lungs.

Bodies of the first victims turned yellow shortly after being brought out of the building, and later turned green. This is said to be symptomatic of death from inhalation of nitrogen peroxide.

None of the deaths or injuries were, so far as reported, the result of burns.

* * *

The Film Hazard

There are two types of film, similar in appearance, but very different in properties: nitrocellulose film, which is chemically related to guncotton, and cellulose acetate or "safety" film, which has no more hazard than paper or cardboard, and which alone should be used in X-ray photography.

Nitrocellulose film is easily ignited and burns furiously with the generation of poisonous and explosive gases. It may start decomposition with subsequent fire, at temperatures as low as 300° F. Thus the heat of a steam pipe or an electric light bulb may be sufficient to start fire. Extreme care is required to avoid ignition from such sources not ordinarily thought of as fire hazards.

Storage of the nitrocellulose films should be in vaults or cabinets, so arranged that fire cannot spread from them to other parts of the building. Ample vents are required to carry off the fumes in case of fire.

Automatic sprinkler protection is of utmost importance. Water from sprinklers serves not only to cool the film, extinguishing the fire or at least retarding the decomposition, but also the water spray tends to absorb the dangerous nitric gases. Where film is stored in quantity a special sprinkler equipment, designed to deliver more water than the ordinary installation, is required.

The "Fireproof" Building

This building was fully "fireproof" in the commonly accepted sense of the term. This fire furnishes further proof that no building is truly "fireproof." Fire-resistive construction is of utmost value, but the value of fire-resistive building materials may be largely negatived by improper interior arrangement. It is a relatively simple matter in the original design of a building to eliminate or protect vertical or horizontal openings through which fire or gases of combustion may spread.

REFERENCE MATERIAL

Regulations for the Storage and Handling of Photographic and X-Ray Nitrocellulose Films (Developed by N.F.P.A. Committee on Hazardous Chemicals and Explosives, adopted by Association, and published by National Board of Fire Underwriters in 1925)

Provides for vented cabinets or vaults for film storage, special automatic sprinkler protection, elimination of potential fire causes, etc.

Hospital and Institution Fires (Reprint from N.F.P.A. *Quarterly*, Jan., 1929)

Summarizes 124 typical hospital and institution fires, including previous X-ray film fires in hospitals.

Building Exits Code (Developed by N.F.P.A. Committee on Safety to Life, adopted by Association, and approved as Tentative American Standard in 1927 by American Standards Association)

Section 24 is devoted to hospitals and institutions, covering construction of building, arrangement, hazards, exits. Other sections deal with fire exit drills, fire escapes, stairways, horizontal exits and other features bearing on life safety.

Copies of the above may be obtained from

National Fire Protection Association

60 Batterymarch Street, Boston, Mass., U. S. A.