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# INDUSTRIAL PLANTS

## Chapter thirty:

## Piping – Fluid distribution plants – Plant and equipment for fire protection

**DOUBLE DEGREE MASTER IN**

**“PRODUCTION ENGINEERING AND MANAGEMENT”**

**SEAT OF PORDENONE**

**UNIVERSITY OF TRIESTE**

# Plant and equipment for fire protection

## Generality

The damage caused by fires in industrial plants are very high. At direct damages (destruction and damage of machinery, plant, buildings, raw materials etc.) are added indirect damage (lack of production), which are greater than the first.

It must therefore avoid or reduce both the first that the second through the adoption of appropriate means of prevention and protection.

Practically, it distinguishes between preventive measures and those to extinguish or circumscribe the fire.

# Plant and equipment for fire protection

Generality

**Preventive measures**, that tending to avoid the occurrence of the fire, are:

- use of incombustible structures and fire resistant;
- respect of distances of protection between manufactured and/or plants, and between them and electrodes, fences, roads and railways;
- intervention, at the project level, on the processing and on storage to achieve the conditions of maximum safety;
- implementation of adequate natural or mechanical ventilations;
- use of spark-proof tools;
- adoption of electrical plant "a safety" (according to CEI norms);
- grounding of the plants to avoid the formation of electrostatic characteristics;
- prohibiting smoking and open flames;
- protection against lightning;
- establishment of firefighters of the company.

# Plant and equipment for fire protection

Generality

**Measures for shutdown**, or circumscription of the fire, which are activated when the fire has now been developed and are classified into categories according to whether they are aimed at:

- provide greater security to people (emergency exits, safety clothing etc.);
- split the risk, distancing the most dangerous, creating "fire walls" (non-combustible material at least 25 cm thick on plastered bricks and 15 cm in concrete), "water barriers" (nozzles installed on a pipe elevated under pressure, which allows you to isolate adjacent areas, by preventing the spread of fire and limiting the effects of radiation) etc.;
- promptly report the fire, using special signaling plants;
- turn off or at least contain the fire, mediated adequate firefighting equipment.

# Plant and equipment for fire protection

## Classification and kinetic of the fires

On the basis of substances which feed them, one has the following classification of fires:

- class A: fires of solid fuels and resulting in the formation of coals, due to different materials (paper, wood, textiles, coal, rubber, leather etc.);
- class B: fires of flammable liquids (gasoline, solvents, oils, paints, resins, ether, alcohol, etc.);
- class C: fires of flammable gases (methane, acetylene, hydrogen, etc.);
- class D: metal fires light fuels (sodium, potassium, magnesium, calcium, barium, etc.);
- class E: fires originating from live electrical equipment (transformers, motors, generators, alternators, switches, etc.).

# Plant and equipment for fire protection

## Classification and kinetic of the fires

To refering at UNI-EN norm, there are the four classes of fire:

- **class A**: fires from solid materials, usually of an organic nature, in which combustion takes place normally with formations of embers;
- **class B**: fires in liquids or solids liquefied;
- **class C**: fires from gas;
- **class D**: fires from metals.

A fire is an oxidation process where the flames of violent represent the most striking aspect and last of a series of phenomena.

Classification and kinetic of the fires

Typical is the case of organic substances, whose process of oxidation is continuous and the faster the higher the temperature. It causes the development of heat which in part must be dissipated and in part to increase the temperature.

If the thermal balance is positive, the phenomenon is enhanced by passing from a production of CO and $CO_2$ to a stage of distillation of the volatile products (fuels); then reached the temperature of ignition or ignition point, it passes by the formation of embers to fire, which becomes the vehicle propagator of combustion.

Classification and kinetic of the fires

The flammable liquids emit vapors as a function of their vapor pressure, variable from liquid and increasing with the temperature.
Vapors from flammable liquids, mixed with air and reaching a certain concentration, may, with a trigger, burn and explode (burn fuel vapors and the liquid evaporates it cools).
Each fuel is characterized by a **switch-on temperature** (at which ignites spontaneously in the presence of air) and an **ignition temperature** (at which ignites in the presence of ignition combustion).

# Plant and equipment for fire protection

## Fire load

A fire is a phenomenon highly unpredictable in its evolution and that does not always lend itself to a theoretical framework and quantitative.

To give an idea of the degree of danger presented by a building containing combustible materials, has been called the **fire load factor**, which measures the number of calories that can be developed per unit area of the building.

In addition to what, is necessary to know the time during which these calories will be developed, that is, the speed of combustion; this depends not only on the material, fuel, state of dryness and subdivision of the same, from the ventilation conditions, ambient temperature etc.

Fire load

The fire load can be estimated from the relationship:

$$q = \frac{\sum_{i=1}^{n} (g_i \cdot H_i)}{A}$$

where:

q = fire load (kJ/m$^2$);

$g_i$ = weight of the combustible substance i-th between the n substances present in the local (kg)

$H_i$ = calorific value higher of the combustible substance (kJ/kg);

A = total area of the local (m$^2$).

In England, is consider three degrees of risk depending on the value of the fire load:

- slight risk: 637 – 1.129 MJ/m$^2$;
- medium risk: 1.129 – 2.383 MJ/m$^2$;
- great risk: 2.383 – 4.614 MJ/m$^2$.

# Plant and equipment for fire protection

## Fire load

The duration of a fire depends on the fire load on the basis of experimental investigations have identified the following correlations:

- fire load 460 MJ/$m^2$ duration of fire 15 minutes;
- fire load 460 – 920 MJ/$m^2$ duration of fire 40 minutes;
- fire load 920 – 1.840 MJ/$m^2$ duration of fire 100 minutes;
- fire load 1.840 – 2.760 MJ/$m^2$ duration of fire 180 minutes.

Since the degree of risk and danger varies with the types of processing and of materials stored, appears comprehensible the propensity of the designer towards the fire prevention in local limited and separated or spaced between them, and for construction systems of buildings fire resistant.

The optimization of plant layout of an establishment, the organization of production, of the interiors transport etc. is favored by local very large, seamless, with warehouses and processing without protection and fire walls, on the other hand the'' fire is all the more dangerous the more extensive is the area concerned.

# Plant and equipment for fire protection

## Fire load

It is to identify from time to time the solution which combines in the best way the two needs, achieving the required degree of security and preserving the criteria of rationality of the project of the plant.
To obtain this result should be prepared of the plants of shutdown and alarm suitable, as well as surfaces of venting of heat and smoke of sufficient area.

# Plant and equipment for fire protection

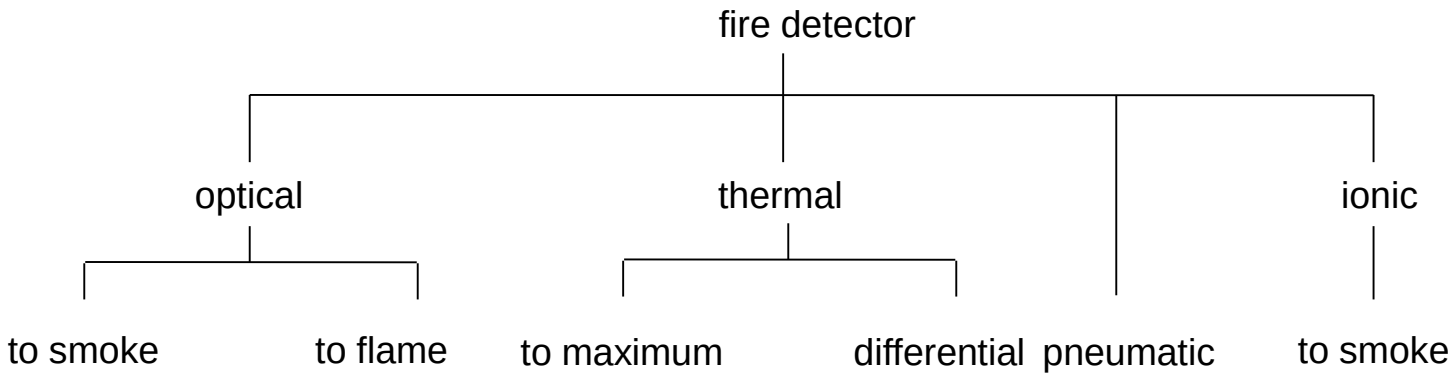
## Signal fire

Is important the signaling of a fire, both for safety reasons, that to anticipate the intervention and limit the damage.

Have been developed numerous systems of detection of fires, which are based on physical and chemical alterations that cause a fire in the environment in whose is develops.

The choice of the most suitable type is a function of the risk to be protected.

The main detectors in current use are:

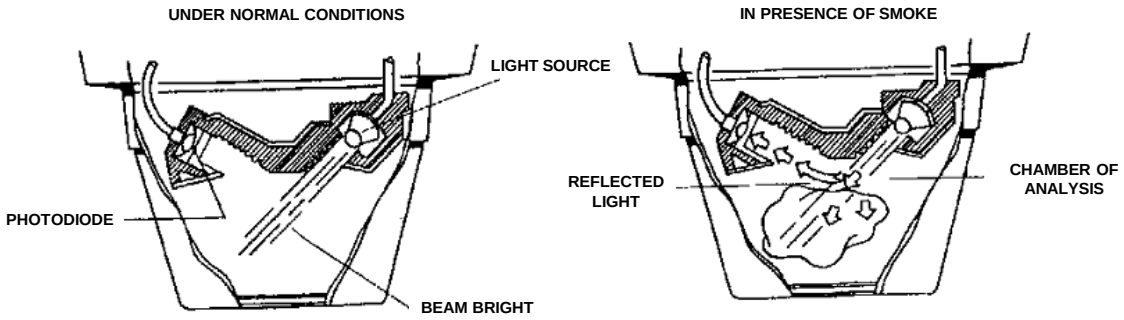


Signal fire

## Optical detectors

a) Smoke detectors

a light beam coming from an incandescent lamp always on lit; if it is crossed by smoke particles, is refracted by illuminating a photoelectric cell which closes the alarm circuit. They are sensitive to those hearths of fire that produce visible smoke.




b) Flame detectors

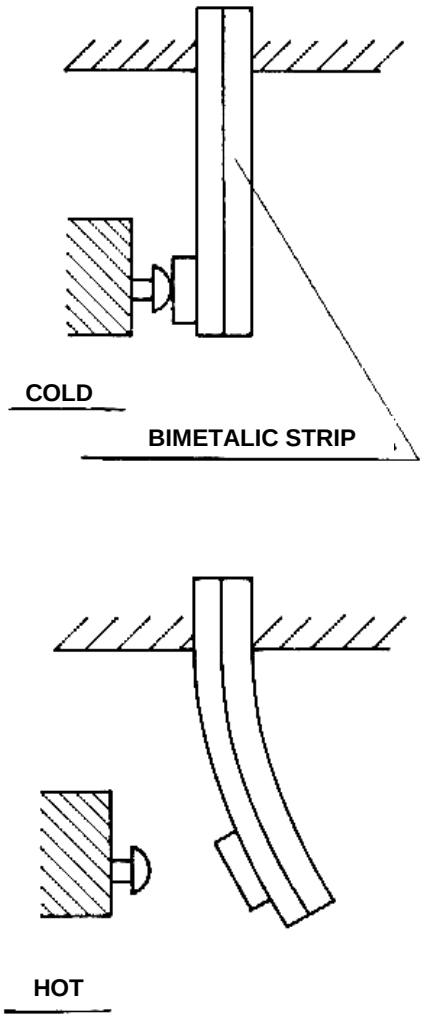
it is a real electronic eye that "sees" the flame, which detects the infrared radiation. Are operating immediately and safely, but their sensitivity can give rise to false alarm signals.

Signal fire

## Thermal detectors

a) Thermal detectors to maximum

A bimetal strip is arranged so that at normal temperatures closes a contact, allowing the passage of a quiescent current in the electrical circuit connected to it. The increase in temperature makes flex the blade (there is a different coefficient of expansion between the two metals) until the contact opens, the quiescent current is interrupted and the alarm is given

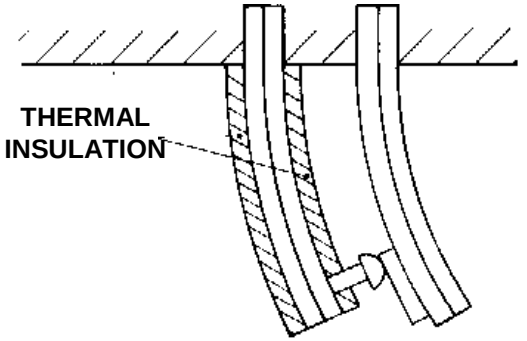


Signal fire

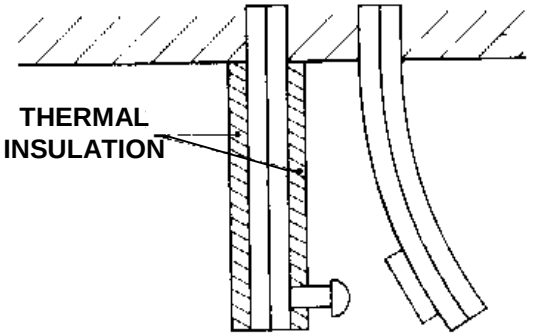
## Thermal detectors

b) Differential thermal detectors

Are based on the same principle as those in maximum. Are constructed so as not to be affected by a slow temperature increase, but only by a sudden increase in temperature (2-10° C/minute). One of the bimetal strips is insulated with respect to the environment, so that free reaches more rapidly the surrounding temperature and flexes before, by opening the contact (if the temperature rise is slow, the two foils have the same behavior)




**SLOW INCREASE IN TEMPERATURE**




**RAPID INCREASE IN TEMPERATURE**

Signal fire

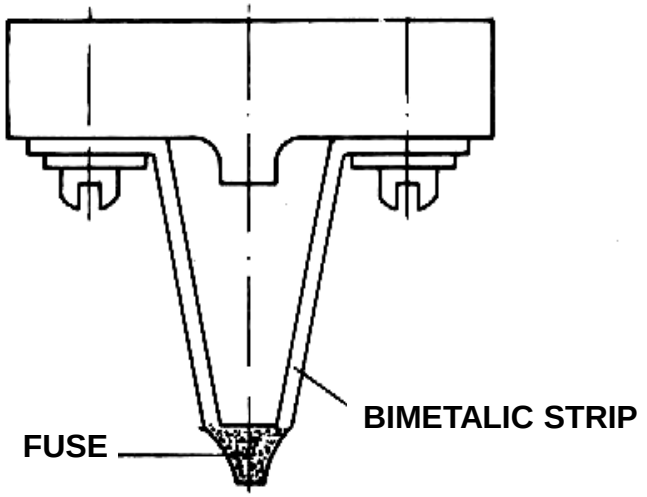
Thermal detectors

c) Detectors semi-differential

Have together the characteristics of detectors thermal to maximum and differential . Are capable of detecting fast changes of temperature and, in case of slow rise of the latter, intervenes at a predetermined temperature

d) Detectors to fuses

Consist of two bimetal strips fixed to each other at one end by means of a substance that melts at predetermined temperature. The rise in temperature removing the blades and makes the pasty substance fuse, at some point the contact is opened causing the issuance of a warning



# Plant and equipment for fire protection

## Signal fire

### Detectors pneumatic

a) Detectors pneumatic at pressure

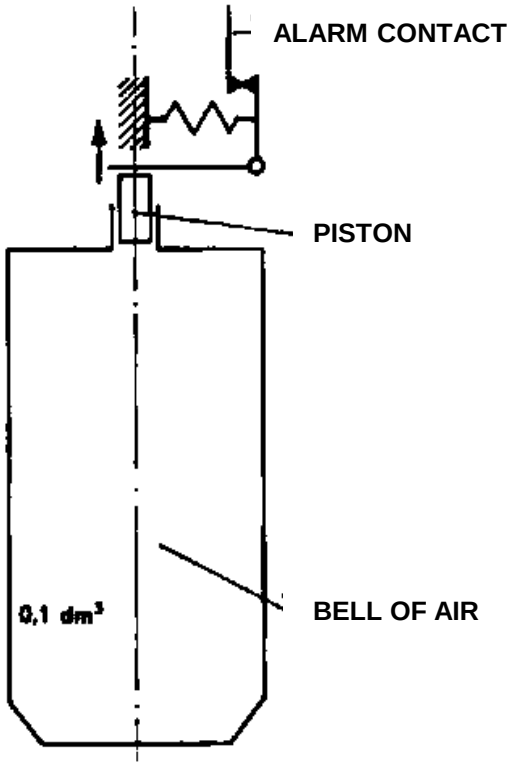
A piping network is maintained under pressure by an electric compressor that operates automatically; along the network are arranged of detection elements in quartz bulb or fuse, which start at a predetermined temperature, causing the air to escape. The sharp drop in pressure starts up the alarm.

Signal fire

Detectors pneumatic

b) Detectors pneumatic at expansion

A circuit which contains air at ambient pressure, mutually connects many small tanks by the thin walls. An increase in temperature causes an increase of pressure acting on a piston calibrated (or on a membrane), which drives the contacts of a relay fast opening and operates the alarm; instead when the temperature rises slowly, the escape of air that occurs through the sealing organs prevents the lifting of the piston. It is a system that is simple and safe (does not require the supply of compressed air), but it is difficult to calibrate.



Signal fire

## Ionic smoke detectors

a) Detectors at ionization chamber

These plants are able to report the first products of combustion. The sensing element is formed by an ionization chamber communicating with the outside (into which can penetrate the fumes and combustion gases), which is constituted by a cylinder containing two electrodes connected to an accumulator battery or a group of transformer-rectifier at selenium with stabilizer at cold cathode. This chamber has the purpose of creating an electric field of the continuous type; operation is based on the decrease of the electrical conductivity of the chamber when in the same penetrate the fumes and combustion gases.

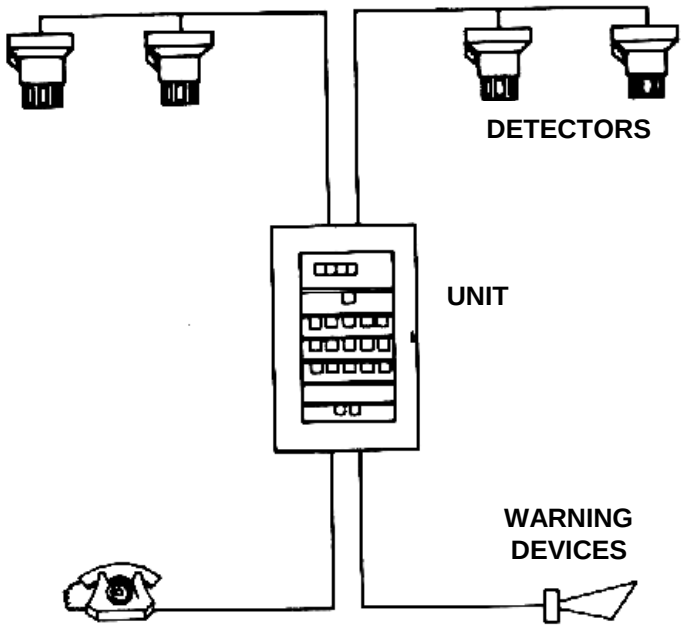
# Plant and equipment for fire protection

## Signal fire

To increase the safety of operation, are installed, in the same environment, two or more detection systems.

The indicator system by means of fire detectors provides an indication, that they transmit to a control unit, that contains the organs necessary for the identification of the organs necessary for the identification of the place where the alarm occurred, it is also with optical indicators, acustic etc.

The control unit is installed in the home or in the local overseers of the custodian or the premises of the Fire Brigade of the plant.



# Plant and equipment for fire protection

## Signal fire

A detection system may be provided in order to place directly in function the system shutdown without it being necessary the intervention of man, even if this results in a lower sensitivity, in order to avoid false alarms which could cause unnecessary and harmful intervention of the fire alarm.
It is not easy, however, replace the presence of man when the extension of the fire allows to graduate the intervention, in such a way as to minimize the damage often caused by the same extinguishing medium.
The automatic operation is indispensable in the case of plants unattended or inaccessible.

# Plant and equipment for fire protection

## General principles of fire extinction

The extinction of a fire can be:

- for cooling, i.e. lowering below the ignition point the temperature of the exposed surfaces;
- by suffocation, namely reducing the inflow of air to the combustion zone, in this way the $O_2$ content drops to values such as to interrupt the combustion; similar effect is obtained by diluting with an inert gas mixture of combustion. For each fuel has a flammable range (lower and upper limit of flammability), which is a function of the temperature and pressure of the mixture of fuel+combustion+inerts, and the relative partial pressures.

Powering off a fire is almost always due to concomitant cooling and choking, with a prevalence of both action depending on the extinguishing medium used.

# Plant and equipment for fire protection

## General principles of fire extinction

Interventions to extinguish a fire can be supported by appropriate measures aimed at facilitating access to the fire, to limit the spread of the latter, etc.
In the case of industrial buildings, it is shown that it is useful to prepare in the coverage of the heat outlets consist from closures which are opened in case of fire: through the same exit gases of combustion, for subtracting heat from the environment.
Although this leak of heat involves an injection of new air that goes to feed the fire, experience has shown that, for adequate amplitudes of the openings, the heat input due to the combustion air entered is less than the amount of heat removed. Furthermore, it avoids the accumulation, under the cover, boiling gas, which frequently result in the yielding of the hedge.

# Plant and equipment for fire protection

## General principles of fire extinction

Values of vents, expressed in percent of the floor area of the industrial building ($m^2$), as a function of the fire load, or of the degree of risk identified by the English classification , are reported in the table.

| Degree of risk | Fire load ($MJ7m^3$) | % area building |
|---|---|---|
| Light | 627 – 1.129 | 0,65 – 1,20 |
| Average | 1.129 – 2.383 | 1,20 – 1,70 |
| Heavy | 2.383 – 4.514 | 1,70 – 2,50 |

# Plant and equipment for fire protection

## Extinguishing media furniture

For each class of fire there are of the agents for and others less.

The extinguishing methods most frequently employed, and the fields of application are shown in table.

| Extinguishing substance | Campo di impiego | No adact per |
|---|---|---|
| Water in the form of jet | Fires of solids. In general, class A fires | Fires in electrical equipment, mineral oils, flammable gases |
| Water nebulized | Hydrocarbon fires and similar, electronic equipment | Flammable gases |
| Foam | Fires of mineral oils, bitumens. In general, fire class B and A | Fires of electrical and flammable gases |
| Dry chemical | Fires of oil, paint, bitumen, flammable liquids and gases, electrical equipment | Fires that develop with formation of embers |
| Carbon dioxide | Electrical equipment, mineral oils, greases, paints, solvents, etc. | Materials that burn with the formation of coals |
| Halogenated compounds | Fires of flammable liquids and electrical equipment | Local large or very windy and substances that forming embers |

# Plant and equipment for fire protection

Extinguishing media furniture

The means to intervene against a fire can be distinguished in two categories:

- **portable**, for localized operations;
- **fixed**, designed to protect an entire room or building.

To the first category belong the various types of fire extinguishers, as well as the means of traditional intervention, such as sand.

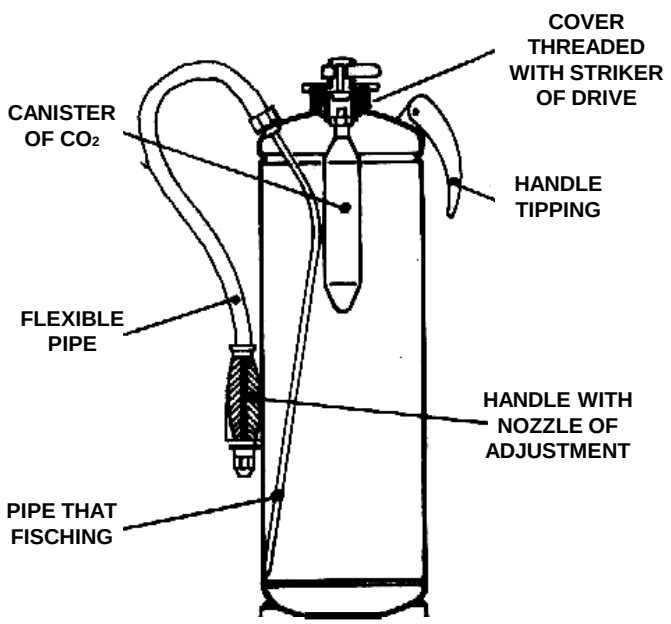
Extinguishing media furniture

Portable means:

a) Water fire extinguishers

They consist of a tank containing water (alone or with the addition of chemicals) and a canister of compressed gas (usually $CO_2$) which at the time of the intervention, pressurizes the tank allowing the expulsion of the liquid.

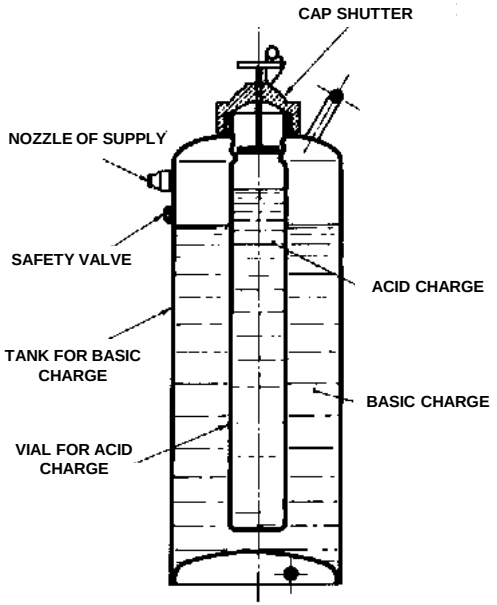
They are suitable as a means of first intervention against fires rising solids (wood, paper, cardboard etc.), but they are not for flammable liquids (oils, fuels, solvents) of natural gas and propane, and electrical equipment.



Extinguishing media furniture

Portable means:

b) Extinguishers at chemical foam




The cylinder consists of two concentric containers; the smallest contains a water solution of aluminum sulphate (upload acid) and the other a basic solution (sodium bicarbonate and licorice powder).

At opening of the valve, the acidic solution it is transferred, in that basic: the gas produced by the reaction acts as a propellant, while the liquid passing through the nozzle forms with the gas a compact mass of foam whose volume varies from 5 to 10 times that initial.

The foam has the ability to separate the fuel from the combustion air and should be projected toward the flames.

Suitable for fire class B and A, and are not recommended for fires of flammable gases and electrical equipment.

Extinguishing media furniture

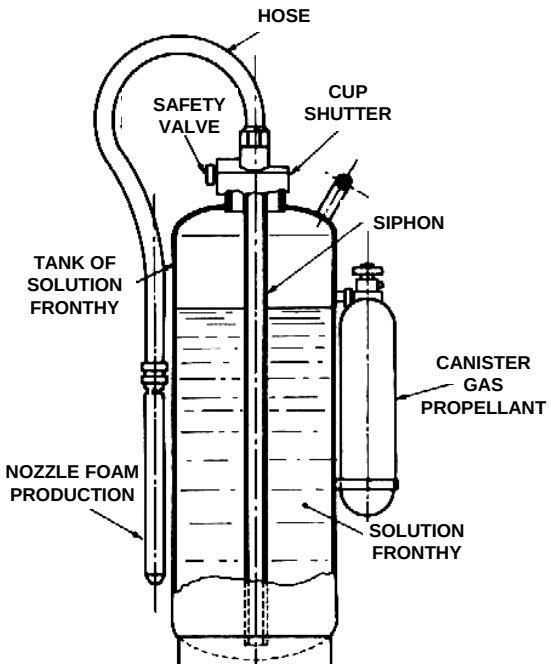
Portable means:

c) Extinguishers at mechanical foam

The foam is formed from an aqueous solution of soap or by hydrolysis of animal protein substances and synthetic. The propellant is constituted by a gas (nitrogen, air or $CO_2$) compressed in a cylinder. The volume of foam can reach 6 - 15 times the volume of the mixture water more liquid foaming.

Switching off occurs for mechanical separation of air from the fuel, with subtraction of heat by the water that evaporates.

Suitable for fires of class B and A, and are not for class E and C.



# Plant and equipment for fire protection

Extinguishing media furniture

Portable means:

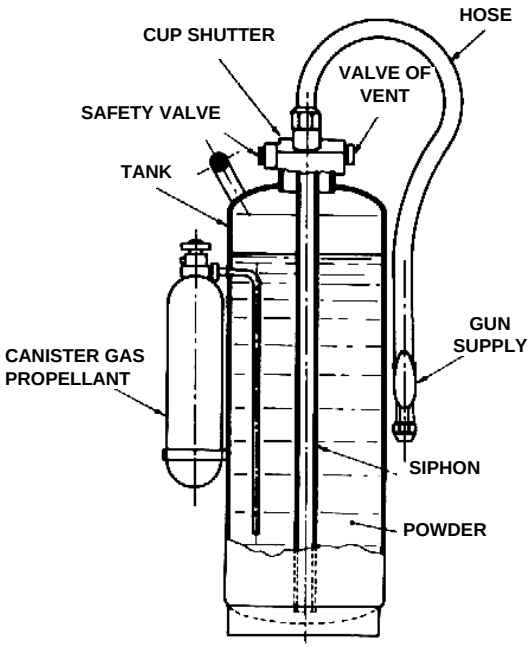
d) Extinguishers at dry chemical

Are particles of alkaline salt (crystals of sodium bicarbonate). Suitable for class B fires C and E, but insufficient to class A.

The work of the bicarbonate stops at the extinguishing the flame, while the embers are they smothered with foam or water.

There are universal powders containing also the monoammonium phosphate, which forms the insulating crust on the fuel choking the embers (suitable for fires of class D).

The propellant used is $CO_2$ or other gas, that is compressed in a cylinder in the auxiliary or main tank together with the powder.



Extinguishing media furniture

Portable means:

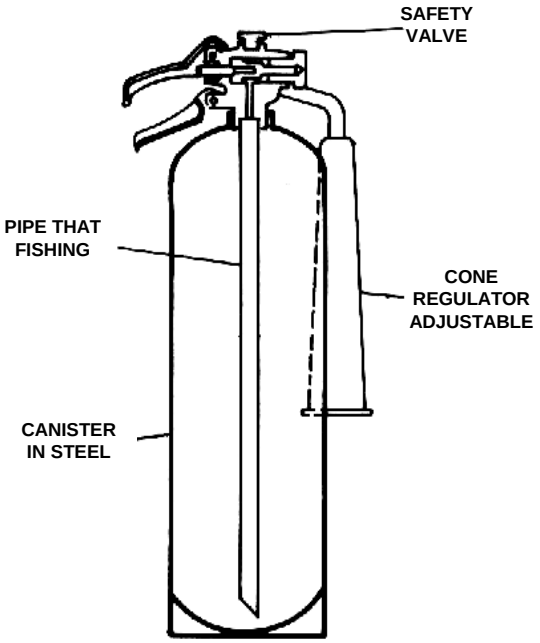
e) Extinguishers at $CO_2$

Are cylinders containing liquefied $CO_2$. At a temperature of 20°C it has a vapor pressure of 58 bar and is located in the vicinity of the critical point of its state diagram. For higher temperatures, the pressure grows for which you should avoid excessive heating of the cylinders.

The extinguishing action takes place not only by suffocation, but also for cooling; the leaking $CO_2$, for the strong adiabatic expansion, is partly transformed into dry ice.

The fire extinguisher is expensive and does not corrode.

Is suitable for fires of class B.



Extinguishing media furniture

Portable means:

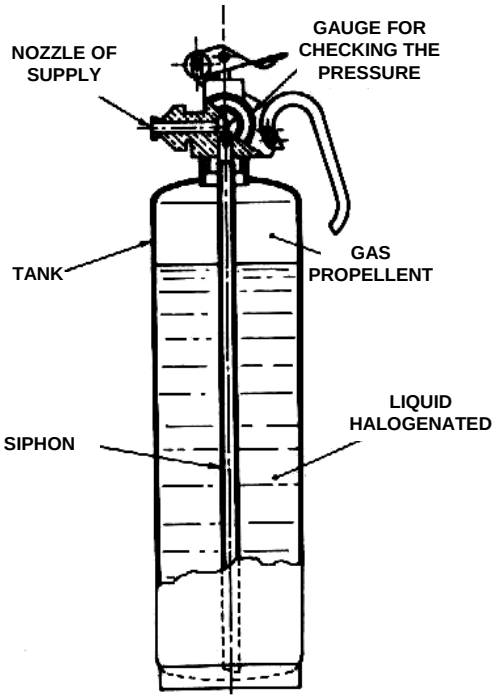
f) Extinguishers at halogenated compounds

The toxic halogenated compounds a low power and high power of extinguishing.

Given that the fire is not only a matter of oxidation, but includes complex chain reactions, whose continuation depends from free radicals, the halogens (boron or chlorine) react with the latter by inhibiting the reactions, so more effective the higher is their atomic weight.

They are suitable for class B fires and E.

Care must be taken to some compound that give off toxic fumes, causing the surface to intoxication.



# Plant and equipment for fire protection

Extinguishing media furniture

All fire extinguishers are made with trolley.

Between moving vehicles are the **self-pumps**, which couple to mobility, high pressure pump (10 bar and more). A jet of pressurized water is clearly more effective than that of a normal hydrant operating at low pressures, not so much for the greater range, but for the possibility of obtaining a jet highly fractionated.

The latter allows to obtain the "stripping" of the flame and greater cooling efficiency, due to the high specific surface of the droplets, and the choking effect for lowering the partial pressure of the combustible vapors.

The pumps used are at diesel or petrol motor for high flow rates up to 1 to 2 m^3/min at 8 bar.

# Plant and equipment for fire protection

Fire-fighting plants fixed

Are the means for extinguishing of greatest potentiality of mobile ones, even though they are usually installed in conjunction with portable means.

a) Plants at hydrants

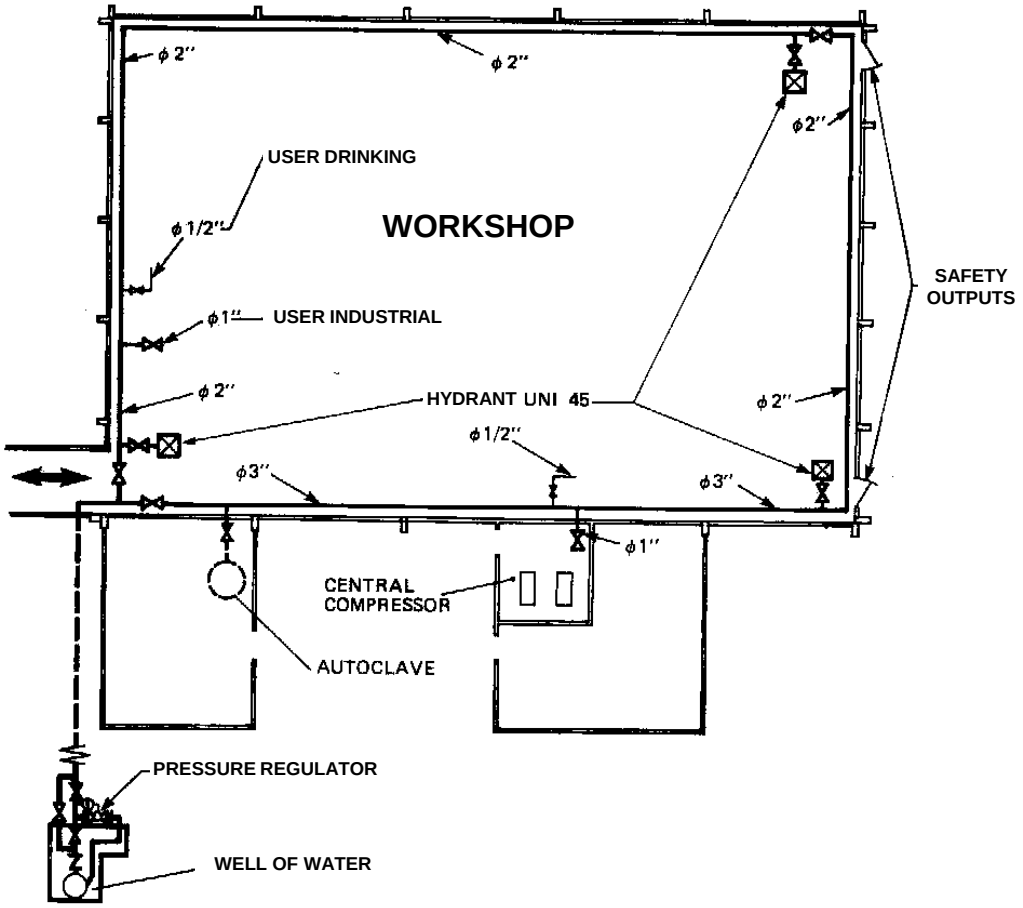
It uses a single network (drinking) water for plants very small and do not require large quantities of industrial water and in which fire hazards are limited.

In general, you should build of the separate networks according to the different uses of water (drinking, industrial and fire), because if the installation of a network of fire-fighting water is a major expense, it can be fully justified in case of fire.

# Plant and equipment for fire protection

## Fire-fighting plants fixed

### a) Plants at hydrants



# Plant and equipment for fire protection

Fire-fighting plants fixed

a) Plants at hydrants

In this type of plant the water supply can come from wells, canals, rivers, aqueducts public etc.

If water is withdrawn from the well and a tank, the pump, intended to supply the fire fighting network, will be equipped with electrical connection preferential or will be connected to a generator or be driven by an internal combustion engine (motor-pump).

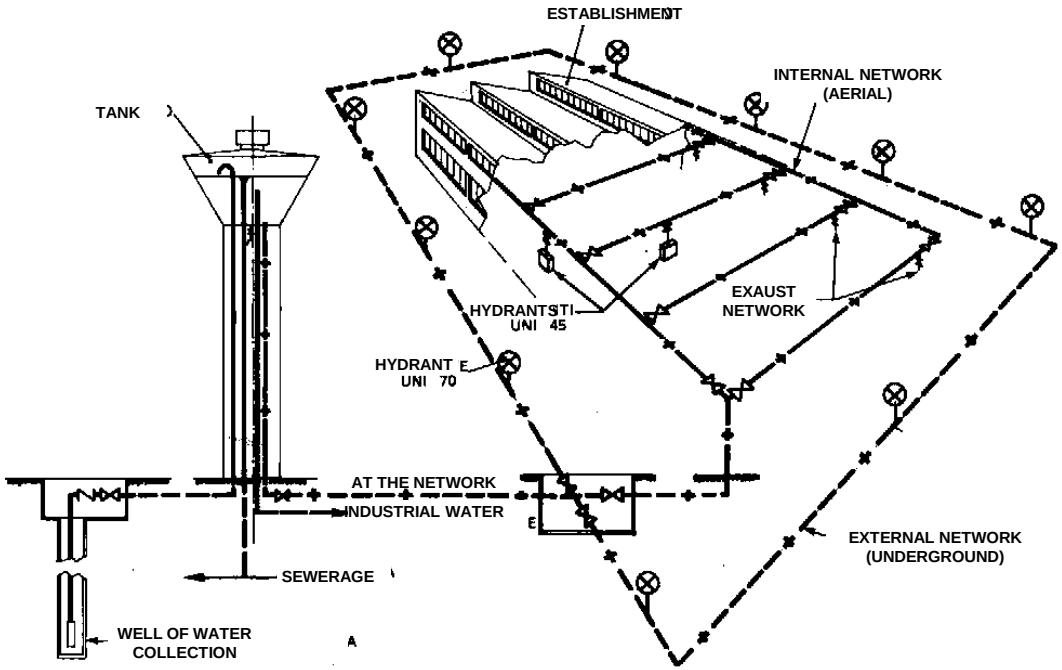
If the power source is the public aqueduct, must be certain that this is able to ensure the minimum pressure required, at any hour of the day, although it is advisable to provide for a reserve of water for the fire-fighting. The connection is devoid of counter, but the gate valves of the individual hydrants are leaded and must be opened only in case of fire.

# Plant and equipment for fire protection

## Fire-fighting plants fixed

### a) Plants at hydrants

The safest solution is the one with raised tank, act to ensure, to the predetermined minimum pressure, an adequate reserve of water in case of fire: the tank feeds the outer ring to the establishment and the eventual internal network.

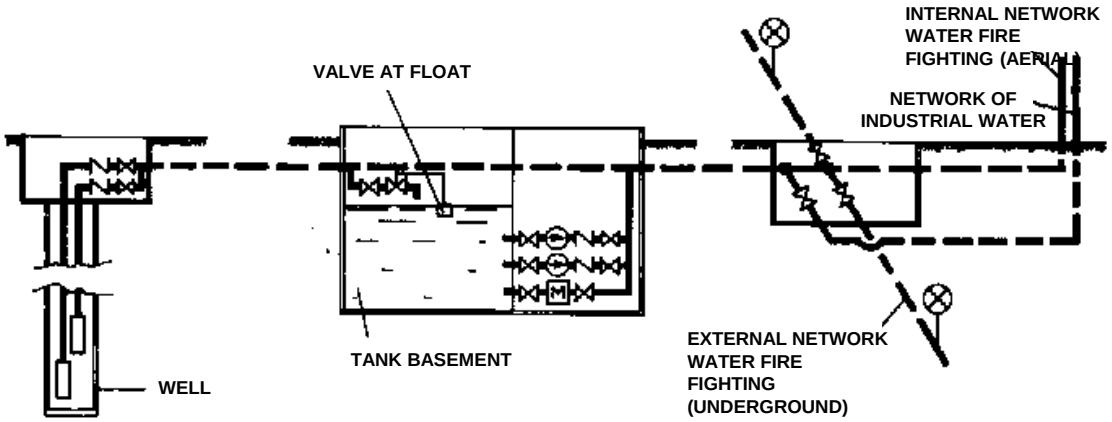


# Plant and equipment for fire protection

Fire-fighting plants fixed

a) Plants at hydrants

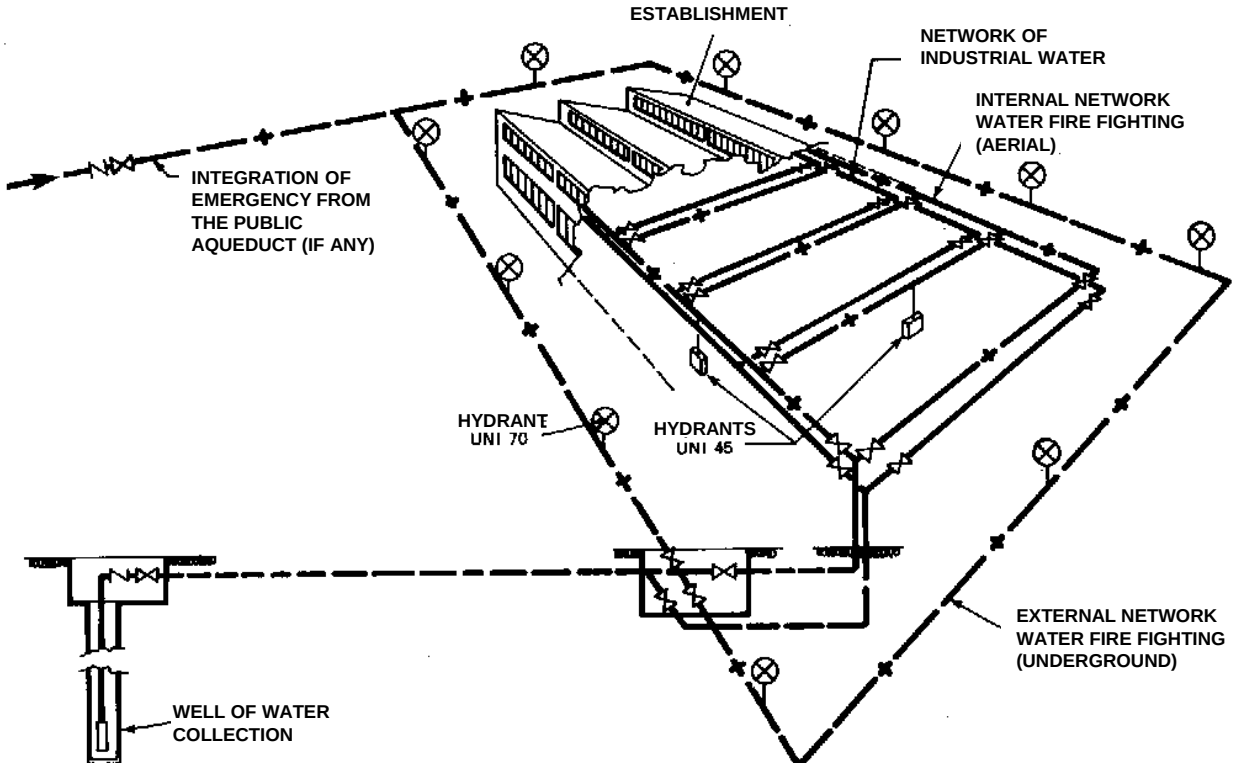
If the pipe comes from the well or from the storage tank which feeds both the industrial network, both the fire-fighting network, it has a pattern of the type of figure.



# Plant and equipment for fire protection

## Fire-fighting plants fixed

### a) Plants at hydrants



# Plant and equipment for fire protection

Fire-fighting plants fixed

a) Plants at hydrants

In an underground chamber, a group of gate valves and derivations connects the main pipe with the network of industrial water, the fire fighting ring outside the building and the fire fighting network internal to the establishment.

Since there is no air tank, if there is a nearby public water supply, provision should be made for emergency connection to it.

# Plant and equipment for fire protection

Fire-fighting plants fixed

a) Plants at hydrants

The outer ring of fire fighting network is constituted by a buried pipe (tube coated and bitumen) installed at a distance of 10 - 20 m from the building. In this pipe are connected fire hydrants spaced in relation to their radius of action useful that depends on the length of the hose, by the water pressure and by the diameter of the nozzle of the lance.

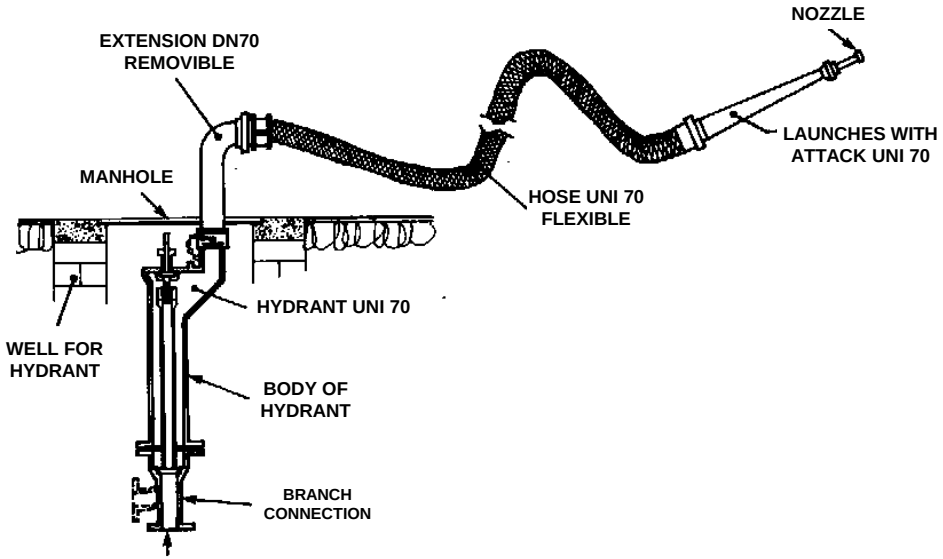
In practice should not be spaced more than 50 - 60 m and it is advisable to have a fire hydrant at each entrance in the building so that it is easy to access with the hoses.

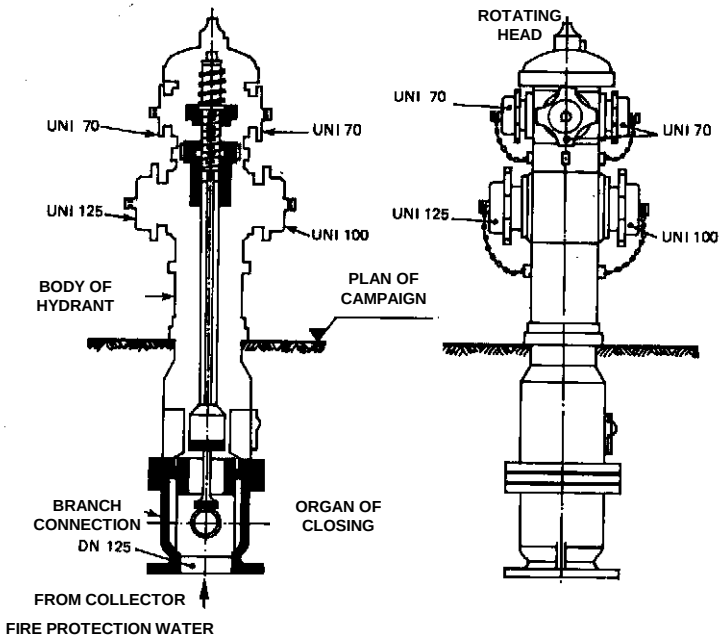
# Plant and equipment for fire protection

## Fire-fighting plants fixed

### a) Plants at hydrants

Instead of UNI70 hydrants, are installed at strategic points superidranti characterized by more attacks UNI70, 100 or 125 (diameter of the water pipe fire)



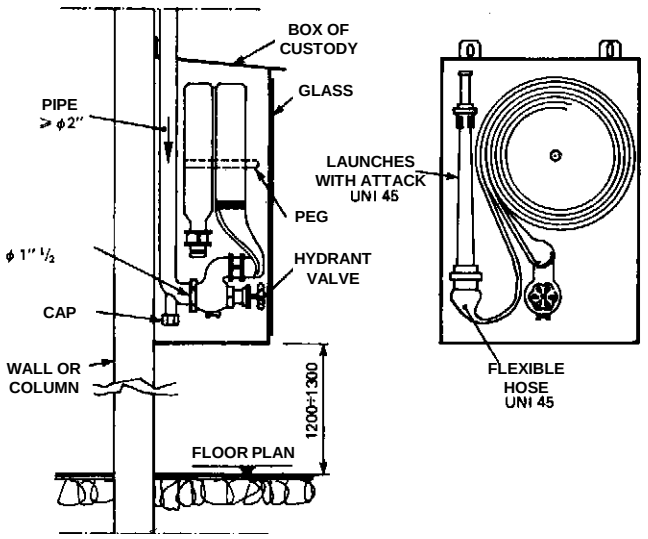



# Plant and equipment for fire protection

Fire-fighting plants fixed

a) Plants at hydrants

Is interposed between the hydrants and the supply line a gate, allowing you to perform any repairs on the hydrant without having to empty the network. The hydrants provided inside the building are of the UNI 45 cassette with hose and lance.




The connection to the network is effected by derivation with tube and shut-off valve of diameter less than 50 mm. The arrangement of the hydrant (hose and lance) is walled on the wall or set on columns or walls, in a prominent position and not bulky.

The distance should be selected in relation to the length of the hose, the water pressure and the diameter of the nozzle.

# Plant and equipment for fire protection

Fire-fighting plants fixed

a) Plants at hydrants

In the design of networks, the source data are the flow of the antifire lance and the water pressure required to ensure the best performance of the hydrants.

The flow rate that is considered is between 600 – 800 $dm^3$/min and minimum pressure of 3 – 4 bar.

The velocity of the water is between 2 –3 m/s.

Known the elements, one can detect the diameter of the tubes and, taking into account losses of load, the pressure to be assigned to the water upstream of networks: it may be noted, therefore, the minimum height of any aerial reservoir or the characteristics of the pumps.

# Plant and equipment for fire protection

## Fire-fighting plants fixed

### b) Plants to rain or to sprinkler

Is characterized by the use of nozzles or "heads" (sprinklers) kept closed by a plate of alloy metalic fuse at a predetermined temperature or by a bulb or ampoule of quartz containing a liquid with high vapor pressure, which, at predetermined temperature, causes the rupture interrupter.

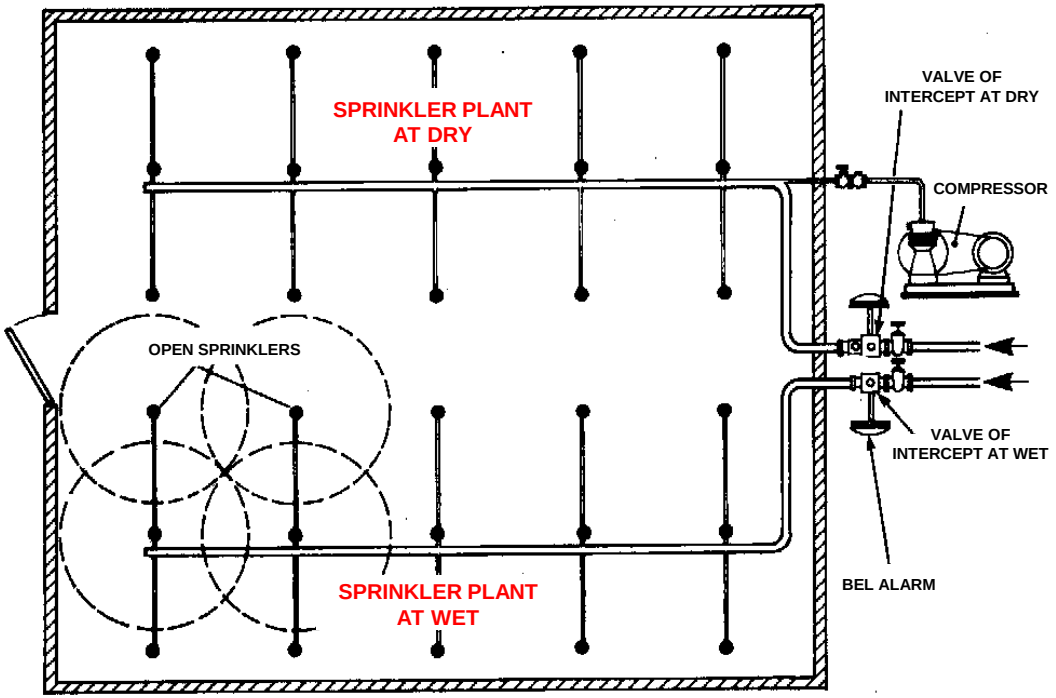
# Plant and equipment for fire protection

## Fire-fighting plants fixed

### b) Plants to rain or to sprinkler

There are two types of plant:

- **at wet**, that is with pipes always filled with water under pressure;
- **at dry**, that is with pipes containing compressed air.

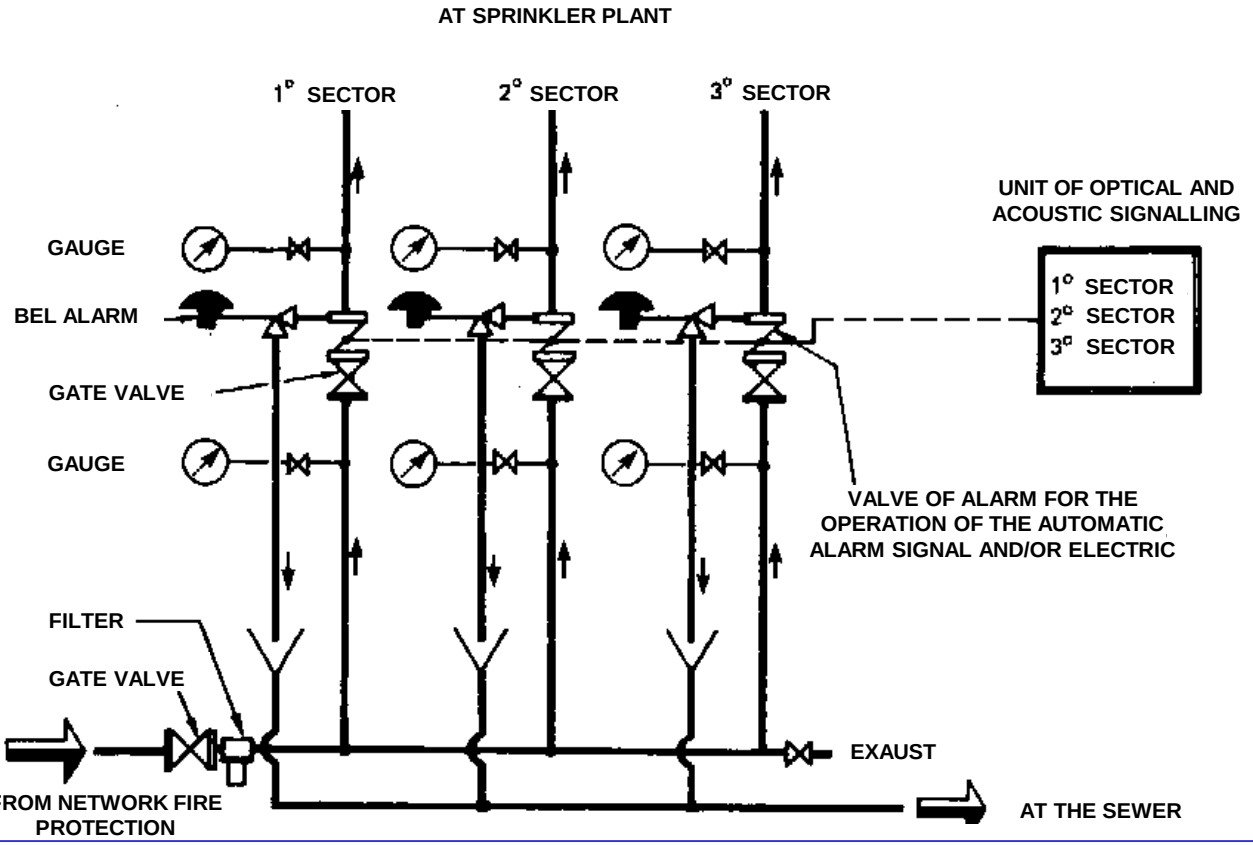


# Plant and equipment for fire protection

## Fire-fighting plants fixed

### b) Plants to rain or to sprinkler

Diagram of a system command, control and alarm of a sprinkler at wet



# Plant and equipment for fire protection

Fire-fighting plants fixed

b) Plants to rain or to sprinkler

The wet plant is the most common, especially for local non subject to freezing. When the ambient temperature reaches the predetermined value, one or more heads are opened, the water of the network on which they are mounted floods the area below spreading, thanks to a special anti-slosh or diffuser, according to a profile roughly conical and at umbrella.

Each sprinkler can protect an area of 7 –12 $m^2$.

# Plant and equipment for fire protection

Fire-fighting plants fixed

b) Plants to rain or to sprinkler

In the plant at dry, the pipes are kept under a constant air pressure. The opening of the spinkler happens to the heat developed by the fire (spinkler thermostatic) or for a rapid increase in temperature (spinkler thermodynamic).

When one or more heads are opened, the air escapes from the network and the valve installed upstream, no longer held closed by air pressure, opens, leaving the way open to water.

# Plant and equipment for fire protection

Fire-fighting plants fixed

## b) Plants to rain or to sprinkler

The advantage of having the pipes empty of water, is payed with a delay of the action of switching off the plant compared to wet; is for this reason that it is generally chooses the plant at wet.

The flow of water in the pipes actuates an alarm that indicates the entry into operation of the plant. The sizing of the pipes does not present difficulties, once it is known that the maximum number of sprinklers to be fed simultaneously, their type and the network pressure. It is adopts a speed of the ducts between 2 and 3 m/s.

Sprinklers are used for a century, as they have a high power of intervention, the correspondence between the area burned and the area watered, security alarm (if mechanical) and limited maintenance costs.

The same insurance companies apply discounts of the premium if the customer takes these types of plants and carried out according to specific rules.

# Plant and equipment for fire protection

Fire-fighting plants fixed

## b) Plants to rain or to sprinkler

Experimental tests and the examining the consequences of fires have brought several technicians to express skepticism about their effectiveness.

It was found that when the sensitive element reaches the predetermined temperature, the temperature of the surrounding air may be much higher (linked to conditions of ventilation of the environment) and the sprinkler reaches the temperature of operation when the fire is now in an advanced development. You can also open not one, but more sprinklers, not all strictly interested.

The opening of the sprinkler is the type automatic, so it happened that the staff rushed to remain powerless, while the fire is spread, waiting for the plant is put into operation. Since the considerable amount of water on the fire inverted from that type of plant, it may have flooding and damage also where the fire has not arrived.

# Plant and equipment for fire protection

Fire-fighting plants fixed

b) Plants to rain or to sprinkler

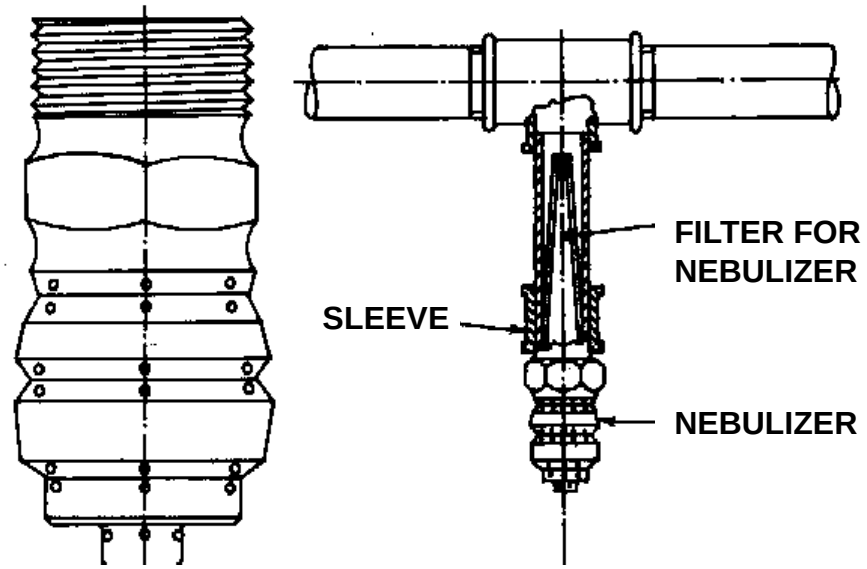
The advantages of this type of system are identified with:

- simplicity of installation;
- safety of operation;
- ability to circumscribe the sinister in a limited area;
- lower the temperature in the area concerned with protection of structures of the building.

Fire-fighting plants fixed

c) Plant at nebulizers

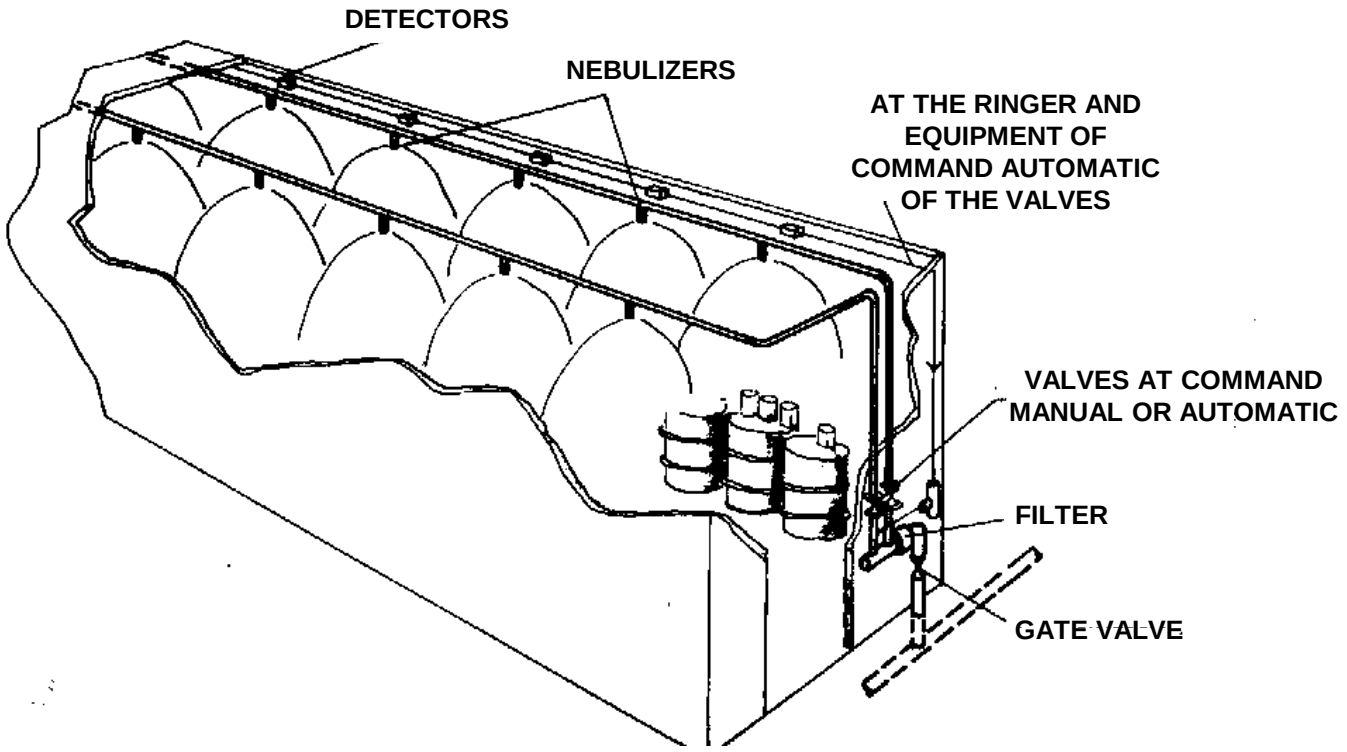
They consist of a series of pipes that lead the special nozzles, always open, which have the task of dividing the water into small droplets and distribute it evenly into a jet-shaped approximately conical or at "umbrella".



# Plant and equipment for fire protection

Fire-fighting plants fixed

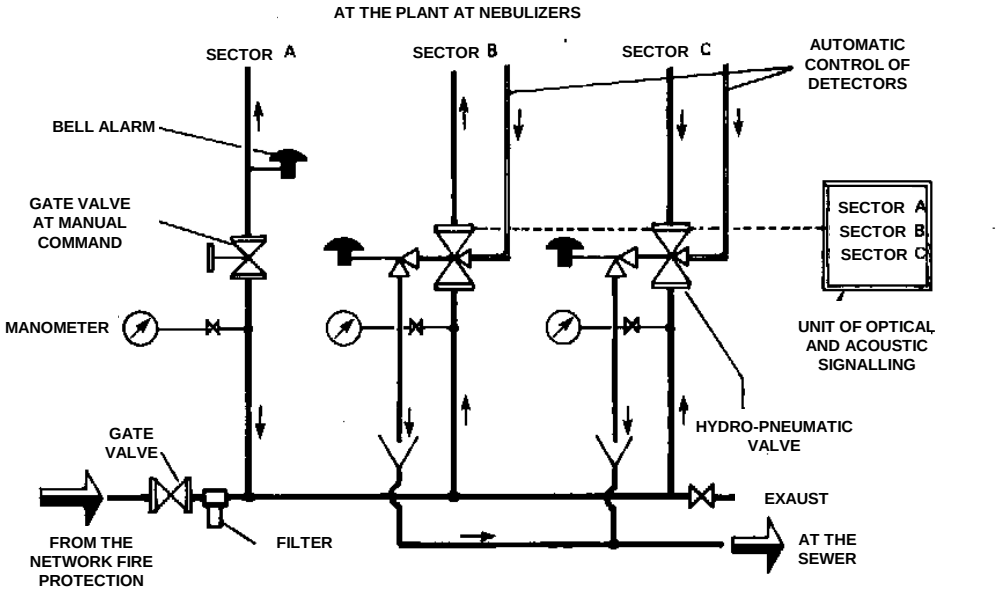
c) Plant at nebulizers



Fire-fighting plants fixed

c) Plant at nebulizers

Are plants of the dry type, therefore, the system is not functioning, the distribution network is empty of water; the supply of the liquid occurs only following the opening of a valve to manual or automatic control. The opening of the valve causes the entry into operation of an alarm, almost always of the hydraulic type.



Fire-fighting plants fixed

c) Plant at nebulizers

The area to be protected is normally divided into several zones, in order to limit the water supply to the areas that require it.

There are several types of nebulizers according to the necessities, flow rates, pressures and subdivisions of the water, however the protected surface is approximately equal to that of the sprinkler.

The consumption varies between 20 to 120 $dm^3$/min depending on the diameter, the manufacturer and the water pressure in the network.

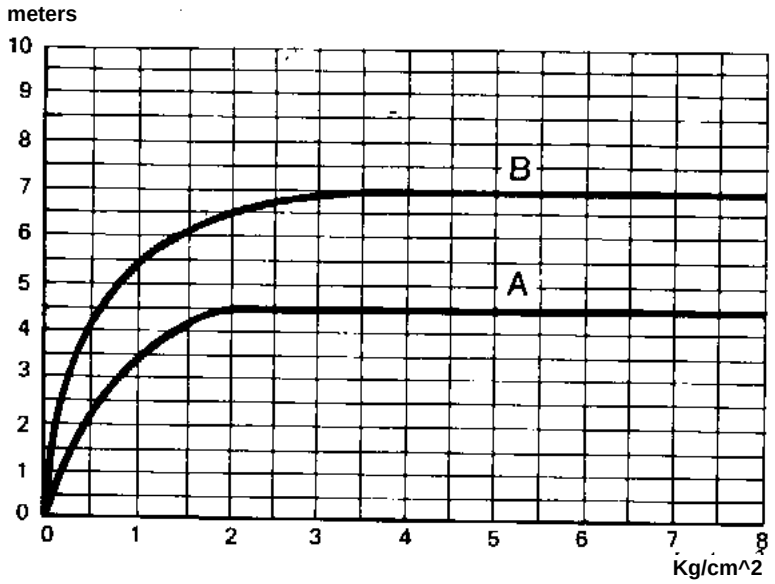
For each type of nebulizer, the fineness of the subdivision of the water increases with the supply pressure (not less than 3 - 4 bar).

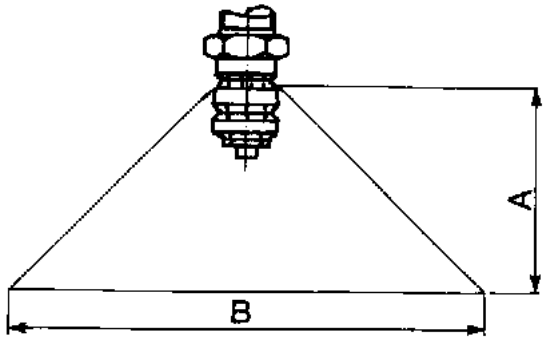
Account must be taken, however, that the jet has never delimited, the angle of the liquid cone is influenced by wear, machining tolerance, clogging and conditions of use, and by the currents of water caused by the jet or fire.

Fire-fighting plants fixed

c) Plant at nebulizers

It is reported in the figure, the characteristics of the water jet nebulizer with a supply hole of the nozzle DN 25, so that it can determine the distance between the nebulisers.



# Plant and equipment for fire protection

Fire-fighting plants fixed

## c) Plant at nebulizers

Established the type and the number of nebulizers, one can calculate the diameter of the pipes and define the entire system, by adopting water velocity of 2 -3 m/s.

This installation is performed by searching the position and the orientation that best meet the specific needs, even if for this type of plant the water upside down on the fire is smaller compared to the sprinklers.

The plant allows of:

- spray shares not yet licked by the flames, preventing the spread;
- dilute with water masses hazardous combustible gas that can accumulate in areas not yet reached by the fire;
- cool the metal structures whose failure could have disastrous consequences.

# Plant and equipment for fire protection

Fire-fighting plants fixed

## d) Plants at $CO_2$ at high pressure

Is consists of a bank of cylinders of $CO_2$ in the liquid state and connected, through a network of pipes and valves, to the nozzles that deliver the form of gas. The principle of operation is different from the portable fire extinguishers $CO_2$: the system acts by suffocation as the dispensing takes place through special nozzles, renouncing in part to the effect of cooling and that the detaching of the flame.

# Plant and equipment for fire protection

Fire-fighting plants fixed

## d) Plants at $CO_2$ at high pressure

The plant is designed to totally saturate the local, locally saturate it and to perform a slow discharge.

For the action of choking to be effective, it is necessary that the environment is completely closed (openings must close automatically).

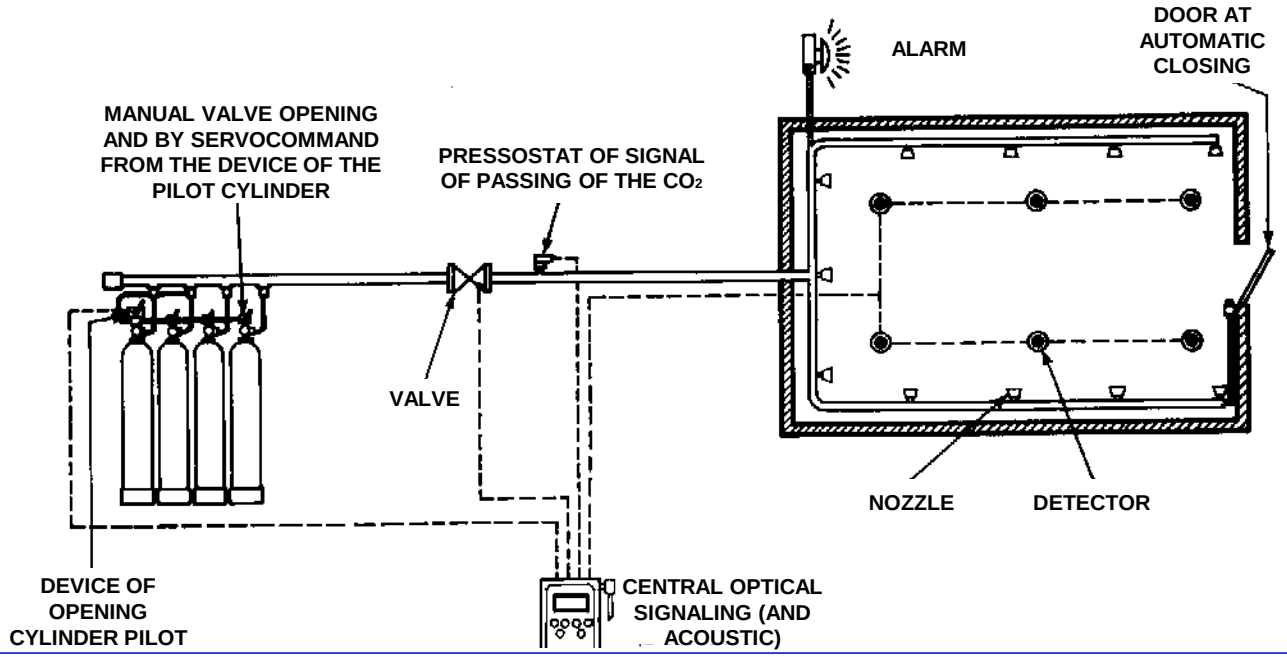
The intervention of the $CO_2$ must be reported with absolute security to enable staff to move away from the environment, then the alarm bell to be operated by the same $CO_2$.

Fire-fighting plants fixed

## d) Plants at $CO_2$ at high pressure

The cylinders are often attached to a wire rack mounted on an automatic weighing system, that lets you know the amount of $CO_2$ available and notice any losses.

It is reported a diagram of the plant.



# Plant and equipment for fire protection

Fire-fighting plants fixed

d) Plants at $CO_2$ at high pressure

Compared to that of high pressure, these plants do not use cylinders at ambient temperatures, but are placed in a refrigerated container at a pressure of 25 bar and at a temperature of -12°C mounted on a balance.

The tank is insulated and provided with safety valve, pressure gauges with electrical contacts for automatic operation of the refrigeration unit and attack for filling.

Is consists of a more complex plant compared to that of high precision, but allows multiple interventions and prolonged and not for protection of local small and delicate machinery, as is that high pressure.

# Plant and equipment for fire protection

Fire-fighting plants fixed

## d) Plants at $CO_2$ at high pressure

The detection system can be pneumatic, operating with gas drawn directly from the tank.

For localized operations and entrusted to an operator, they are often provided with rubber hoses fitted at the end of delivery devices with shut-off valve, arising directly from the $CO_2$ cylinder or tank of the plant in the general.

The cost of $CO_2$ systems is relatively high, so the application is reserved for cases of great danger, in which you need an extinguishing agent that does not cause damage.

The use of $CO_2$ is particularly suitable for the protection of electrical and electronic equipment, depots and processing departments paints, archives and libraries, dies and rolling mills, drying kilns and flammable liquids.

Fire-fighting plants fixed

e) Plants at mechanical foam

The emulsion of water, foaming liquids (protein substances or synthetic non-corrosive) and air determine the formation of foam, which adheres to the surfaces with the effect to suppress the fire.

Such systems are suitable for extinguishing fires of class A and B even if the foam must not come into contact with the energized equipment.

If the plant is slightly extended, it is possible to form the foam in a single point and send it with pipes to the dispensers, but, given the viscosity of the product, for longer distances of a few meters, it is necessary that the foam is formed by zone , in as many equipment foaming.

The expansion ratio is between 6 and 15. You can use high-expansion foams with expansion ratio of 1:1000 and form bubbles of about 10 mm in diameter.

# Plant and equipment for fire protection

## Fire-fighting plants fixed

### e) Plants at mechanical foam