The nature of fire.

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Kinocrat Films Ltd.

Publication/Creation

London : Fire Protection Association, 1969.

Persistent URL

https://wellcomecollection.org/works/ba6sbxa8 an FPA Film

The Nature of Fire

"Fire, the mystic ... Fire, the Thunderbird ... Fire of Hephaestus, and of Bast - fire of many gods .. Partner to brimstone, byword of the devil ... Fire - destructor of all things ...

Such was the ancients' understanding of fire.

But, today, we know all about fire; we realize that its effects are predictable, that it follows well-defined rules, and we put fire to work for us.

Unlike the ancients, we understand fire ...

... or do we? Do we really appreciate that fires don't just happen - that they are caused by ...

... people?

To understand the very nature of fire, it is useful to consider the process going on inside a single gas flame.

It's a chemical reaction, in which the fuel - coal gas - is combining with the oxygen in the air. Quite simply, the gas is burning.

The same reaction is taking place inside this candle flame - although the fuel, this time, is paraffin wax; but like the gas flame it burns in the oxygen of the air. Oxygen which comprises one fifth of the atmosphere.

By cutting off the supply of air, the flame will die out when the oxygen in the jar is used up. At the same time, water is forced up into the jar to take the place of the oxygen consumed.

So, besides a fuel, fire needs oxygen.

But fuel and oxygen are not enough to start a fire. Fire also needs heat.

Fuel ...
... Oxygen ...
... and Heat - the formula for all fires.

The fuel in this fire is wood. At first sight, it appears that the wood itself is burning, but, in fact, it's a flammable gaseous material, which is given off by the wood as it becomes heated.

Under controlled conditions, these gases can be obtained by heating wood shavings. The gases can then be ignited some distance away from the actual wood.

The same principle applies to this wax taper. The heat of the flame vaporizes the wax which, in this form, is then prepared to burn.

This is true for coal - and even for paper. In fact, every solid fuel must be heated to the point where it gives off a vapour, before it can burn.

When a sheet of paper is ignited, the gases burn immediately they have left the heated paper; so it appears that the paper itself is burning. Because combustion of this nature takes place so close to the fuel, the heat emitted causes more combustible vapours to be given off, which, in turn, generate more heat as they burn. The cycle continues until the fuel is completely consumed. This 'chain reaction' is the basic principle of all fires.

A solid piece of wood is difficult to ignite with a relatively small flame, because the amount of heat applied is insufficient to start the reaction immediately (so the heat is therefore conducted away from the area being heated).

On the other hand, a piece of wood, splintered like this, will ignite easily. One shaving will quickly be raised to ignition temperature, and the chain reaction will start.

Some solids can be so finely divided that they become suspended in the air as dust-clouds. At a particular density, when each dust particle is surrounded by precisely the right amount of oxygen, even an apparently harmless substance, like flour, can be highly explosive.

The consequences of this happening on a large scale can be devastating. Serious explosions have occurred in flour mills, and other places where fine dusts are generated - including metal-working shops and coal mines. Air-filtering equipment is extensively used to reduce this danger, but even so, every precaution has to be taken.

Unlike solids, liquids are giving off vapour all the time. In the case of flammable liquids - like petrol - there is a certain temperature, known as the flashpoint, above which there is sufficient vapour being given off to sustain a flame.

The flashpoint of many liquids, including petrol, is well below normal atmospheric temperatures, so these liquids are continuously giving off vapours which can be ignited with the smallest spark - even on a cold day. Because of this, flammable liquids are particularly dangerous.

But let's see what happens to petrol vapour when it's not burning.

This shadowgraph clearly shows that the vapour flows over the sides of the beaker, and, as it is heavier than air, the vapour can collect in pockets without being detected. For this reason, a seemingly empty can may still be filled with vapour. This vapour is highly explosive . . .

In this example, vapour from freely evaporating petrol is allowed to pour down a glass tube, where it provides an instant fuse for ignition back to the fuel source.

Many adhesives and paints have flashpoints below room temperature, and are highly flammable. Typical examples are balsa wood cement, nail varnish - and remover, and floor-tile cement. Rooms in which they are used should be well ventilated to disperse the vapour. In draught-free conditions, a dense layer of vapour may build up at floor level. In effect an invisible bomb . . .

But even liquids with high flashpoints, like paraffin, can be very dangerous when the conditions are right.

Since the oxygen of the air, and fuel, in one form or another, are with us in abundance at all times, it is clearly heat that always starts a fire.

Heat can be generated in several ways. Perhaps the earliest method to be discovered was friction. By rotating a wooden drill on another piece of wood, primitive man at last had a means of producing fire.

So much heat can be generated by two surfaces rubbing together, that today the phenomenon is even put to use in welding metals.

Many conventional workshop processes, including cutting, turning and grinding, generate heat by friction.

The sparks from this grinding wheel are actually metal fragments which have been raised to white heat by friction.

So, in any workshop where fast-moving machinery is used, there is a potential fire hazard - bearings, especially, can become dry and over-heated, and only careful maintenance can prevent the possibility of fire.

Heat can also be generated by electricity.

When a current is conducted through a wire of high resistance a very thin wire - the wire gets hot.

This property of electricity is put to work in many appliances, which have been specially designed to utilize the heat generated in this way, with complete safety.

But if the heat generated is not allowed to disperse in the way intended, overheating will occur, and nearby flammable materials may well catch fire.

The forgotton electric iron is a firm favourite for starting fires in this way.

But less well-known is the fact that if electric wiring is loaded above the maximum for which it was designed, it too may well become hot, and may set fire to its insulation, and to nearby flammable material.

Already, this socket is overloaded, and the wiring is heating up. When the wiring gets hot enough, there'll be trouble - yet another needless fire.

So fires are always started by heat.

Heat is transferred from one area to another in three ways.

By Convection ...
... Radiation ...
... and Conduction.

To see how heat, travelling in these three ways, can cause the rapid spread of fire, let's assume that a cigarette end, thrown inadvertently into a waste-paper basket has started a small fire in a room in this house. Unless the fire is quickly dealt with ...

... radiation, conduction, but mainly convection, which is the most important factor in spreading fire, will soon ensure that the house is completely ablaze.

However, if the door of the room is kept closed, as it is now, the supply of air will be restricted and the fire will be contained within the room for much longer, allowing more time for escape and a better chance of saving the rest of the house. It is even possible that the fire will die out altogether.

But if the door is opened, causing a sudden increase in the supply of air, the fire will leap back into life, and ...

... the heated air and products of combustion, which can weigh as little as one quarter of the weight of ordinary air and can have a temperature of about 1,000 ^{o} C., will rise straight to the top of the house passing on their heat to nearby flammable materials.

If the doors upstairs are open, the upper rooms will be immediately attacked and the whole building will probably be destroyed.

Every year, fire exacts an appalling toll of death, injury and destruction. There is vast damage to property, hundreds lose their lives, thousands are injured.

The answer to much of this problem lies in the old maxim about prevention being better than cure.

Properly secured paraffin heaters, for example ...
The correct use of electrical installations ...
Properly discarded cigarette ends ...
Carefully maintained machinery ...
Properly sealed cans.

Above all, it must be remembered that although the chemical reaction called fire is started by fuel, oxygen and heat, fires are usually <u>caused</u> by people.

Fire Protection Association

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W & Co. 3/73 300

ELF RT Cine Projector

1: Remove loose jacket from projector. Remove speaker lead from jacket pocket.

2: Remove Speaker/Cover from projector.

3: Place projector in position facing screen.

4: Pull reel arms into the vertical position. Click stop in position.

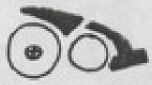
5: Pull out mains cable, plug in and switch point on.

6: Switch on projector. Large switch clockwise one stop. Switch on lamp - a further clockwise turn one stop. Position image on screen. Vertical height is adjusted by the large black wheel at front base of projector.

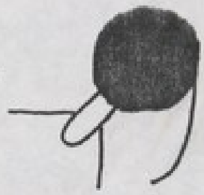
7: Position speaker in a safe place. Run out wire, plug into speaker and into socket on front of projector (labelled Speaker).

8: Ensure amplifier is switched on (left hand of three smaller knobs). This is also the volume control (other two are bass and treble tone controls).

9: Ensure catch at 'A' is horizontal.

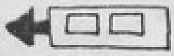


10: To thread film, push large plastic lever, at 'B' in direction of white arrow until it locks (clunk).



11: Place full spool of film onto front arm, ensure you lock it on. Check that the end of the film is clean cut and not frayed or torn. If necessary use the film trimmer (next to 'B') to make a clean cut on film. Put empty spool on the rear arm.

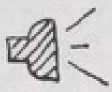
12: Switch projector to forward - large knob clockwise to the symbol:-



Insert film gently at 'A'. Wait until about 2 feet has been threaded out of the rear of the projector. Stop projector.

13: Give film a gentle tug to release the auto-thread mechanism (clunk), and thread the film onto the rear spool.

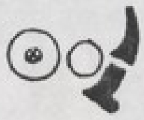
14: To show the film switch projector to forward and then on to the second switch position.

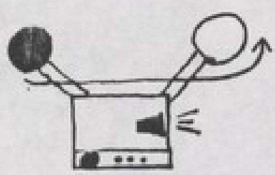


15 To focus turn the large knob labelled 'C'.

16: **REWINDING**

Leave the spools exactly where they are. Move catch 'A' to the vertical position. Thread the end of the film onto the front spool. Switch projector to forward. After rewinding always return Catch 'A' to the horizontal position.





PROBLEMS

FILM NOT THREADING	Is the auto thread mechanism set properly (10)? Is the film damaged? If necessary trim the end (11). Are the sprocket holes on the correct side? If not rewind (16).
NO SOUND	Is the amplifier turn on/up (8)? Have you plugged the speaker lead in correctly (7)?
PICTURE BLURRED	Have you focussed properly (15)? Is the lens steamed up?

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