girish nelavadge. 856110.

exploration in flame forms.

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A report of special project

EXPLORATION IN FLAME FORMS.

by
GIRISH V. NALAVADE.
Roll no.- 856110.

submitted in partial fulfilment of the requirements for the award of Master of Design degree in Industrial Design.

GUIDE- PROF. A. G. RAO.

INDUSTRIAL DESIGN CENTRE.
INDIAN INSTITUTE OF TECHNOLOGY.
POWAI , BOMBAY- 400 076.

MAY, 1987.

approval sheet

The special project titled EXPLORATION IN FLAME FORMS by Girish V. Nalavade is approved for the partial fulfilment of the requirements for the Master's Degree in Industrial Design.

GUIDE - PROF. A. G. RAO

acknowledgements.....

I sincerely thank Prof.A.G.Rao without whose able guidance this project would not have taken this form.

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GIRISH V. NALAVADE.

index.

introduction.

Since the ascent of man , fire has been playing a very important role in the development of humanbeing. The constructive and destructive superpowers of fire made him principle god on earth, Agni. There are myrid stories about his origin and description of his form,in the mythological books. In Rigveda (R 4.58.3) he has been described as a creature with two heads, three legs, four horns and seven lungs. It is also said that he is born before all evil spirits and therefore has to perform prime role in all religious ceremonies.

Dasbodha says, that it dwells in all the elements on earth either in visible or in invisible form. It's visible form is flame which also has got different forms.Each of which is strongly associated with the particular purpose or use and thus can be predicted very easily for it's meaning. As we are associated with fire and flame from childhood and with it's presence in our daily life we neglect it's visual richness We feel it obvious .

The objective of this project is to generate new flame forms which would behold visual interest in the observer. It has been carried

out in three stages.

A] collection of technical information about flame.

B] study on behavior of flame.

C] generation of flame forms.

flame.

Technically speaking flame is a product of exothermic reaction which is usually associated with luminous zone.

Flames are commonly classified according to three broad categories.

(a) Mode of mixing of reactants

(b) Nature of gas flow through reaction zone in the fluid dynamic sense.

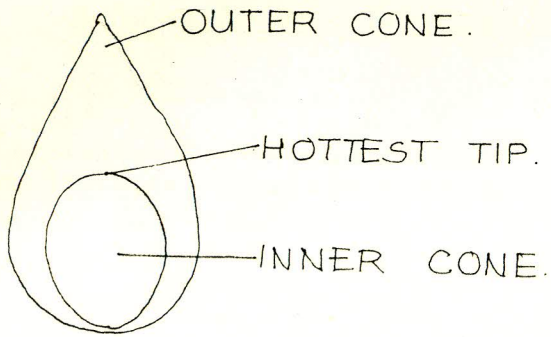
(c) Initial physical state of reactants.

If the reactants i.e. Air and fuel, are mixed before entering the reaction zone. It is called a premixed flame. Example - Bunsen burner flame. In this flanes air/fuel ratio can be adjusted to get desired nature of flame. If the reactants are not premixed, the resultant flame is called diffusion flame. Since the mixing of fuel and oxidizer must be accomplished by diffusion process. In this air/fuel ratio cannot be adjusted and therefore the form of flame depends on the amount of oxygen present in the surrounding.

Many times due to inadequate oxygen, proper combustion does not take place resulted in formation of soot. These flames are mostly with irregular flame front.

If the gas flow lines in reaction zone are parallal to each other, the resulted flame is called laminar flame. This flame is calm and with small half oval shaped flame front. In turbulant flame the gas flow lines are irregular. It has big irregular flame front and it makes hissing sound.

There are three states of fuel- solid, liquid and gas. Solid particle flames are probably typified by those of coal dust in air. Liquid droplets or spray combustion is widely known in common kerosine burners, wick burners etc. while gas flames are still more common in L.P.G. and Oxy-acytylene flame.



COMPOSITION OF FLAME .

Any flame irrespective and it's fuel and burner type, is composed of two cones. Outercone or diffusion zone is respensible for light emission. It is also known as luminous zone. Inner cone or reaction zone is known as flame front. In this zone fuel particles get oxidised. The gas flow lines through this zone determines the charactristics of flame.

NATURAL PROPERTIES OF FLAME :

1. All non-pressurised flames propogate vertically upwards against gravity.
2. It always exists in a continuous flow.
3. It emits light.
4. It evolves heat.
5. It's direction could be changed by introduction of a obstruction in to it's natural flow. It drags on the surface of the obstruction.
6. It's natural colour could be changed into different colour by sprinkling different chemical salts in to it.

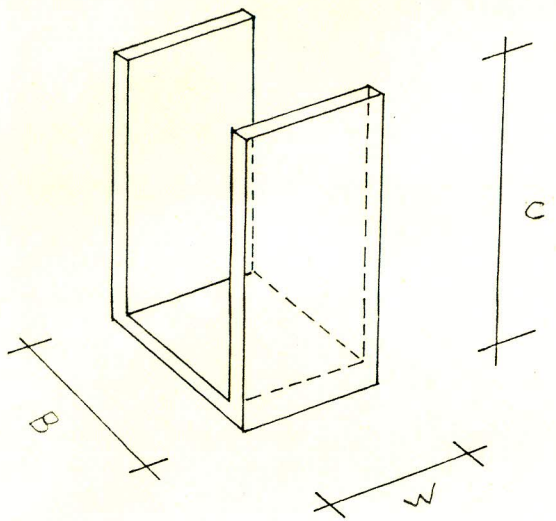
SALT	COLOUR
A. Potassium, Sulphar, Arsenic, Antimony, Magnesium,	Brilliant white
B. Strunsium & Lithium	Red
C. Barium	Green
D. Sodium	Yellow
E. Copper	Blue.

7. In the presence of electric field, it shows affinity towards negetive potential.
8. It is seen prominently in low light.

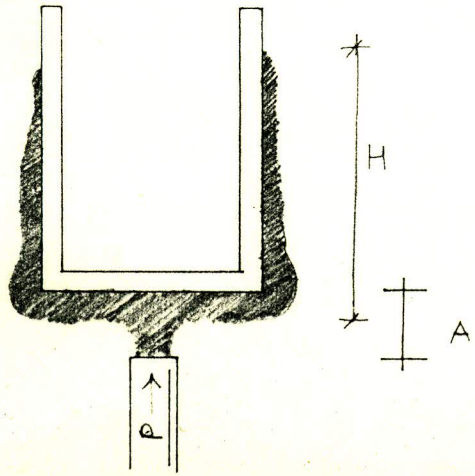
study.

A series of experiments were done to understand the behavior of flame against obstructions of different charactristics. Oxy-acytylene and L.P.G. flames with variation in pressure are used for the experimental purpose. The obstructions used are made of Plaster of Paris and sheet metal.

OBSTRUCTION



FLAME FORM



CONCLUSION

If a obstruction is introduced in flame flow then it's burning velocity drops drastically.

It is possible to tear of the flame along it's vertical axis.

With the introduction of the obstruction it's original direction could be changed.

It drags on the obstruction's surface.

If H - height of the flame.
A - distance between obstruction and nozzle.
B - width of the obstruction.
P - Burning velocity

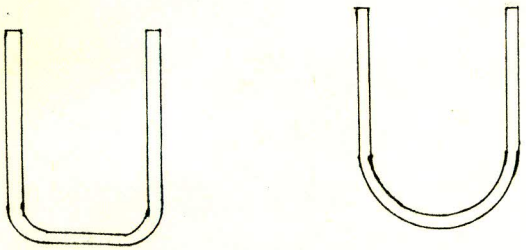
then

$$H \propto P$$

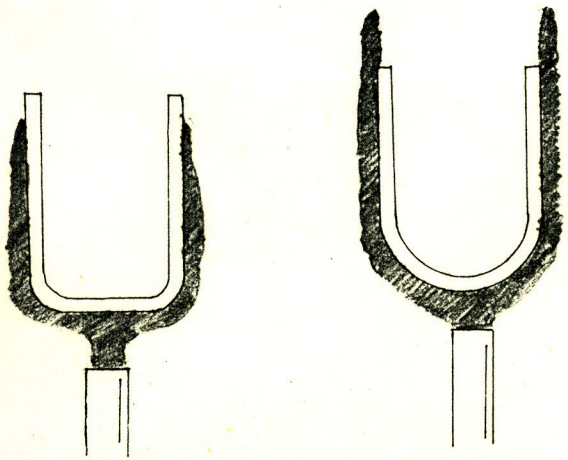
$$H \propto \frac{1}{A}$$

$$H \propto \frac{1}{B}$$

OBSTRUCTION



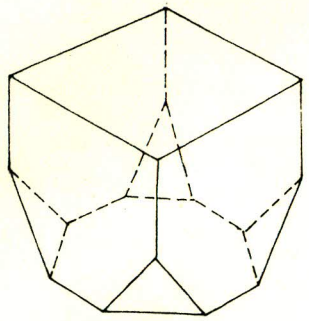
FLAME FORM

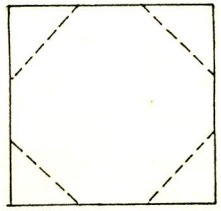


CONCLUSION

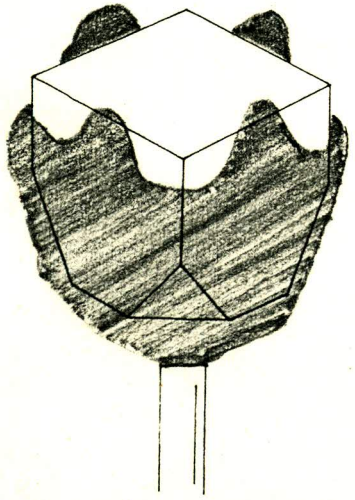
Rounding of the corners causes smooth flow of flame and less drop in burning velocity thereby results in greater flame height. It also converts turbulant flame in to laminar flame.

OBSTRUCTION





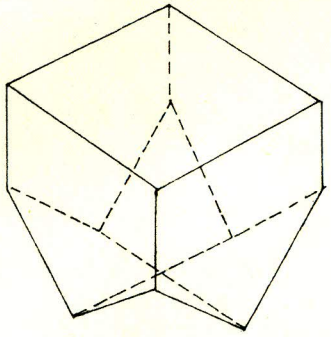
FLAME FORM

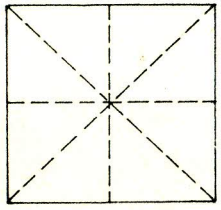


CONCLUSION

Flame gets equally distributed on all the sides, if the obstruction surface facing the flame has equal lateral dimensions.

OBSTRUCTION





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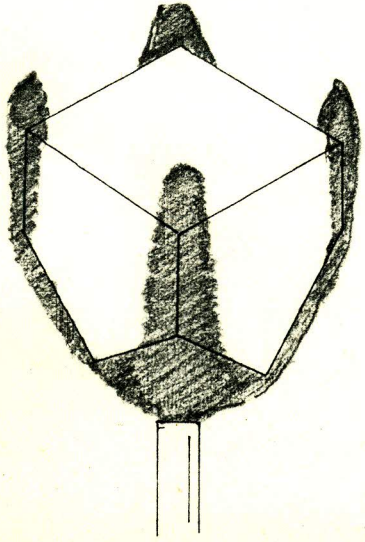
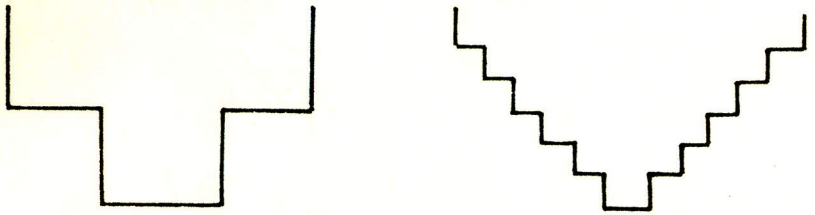


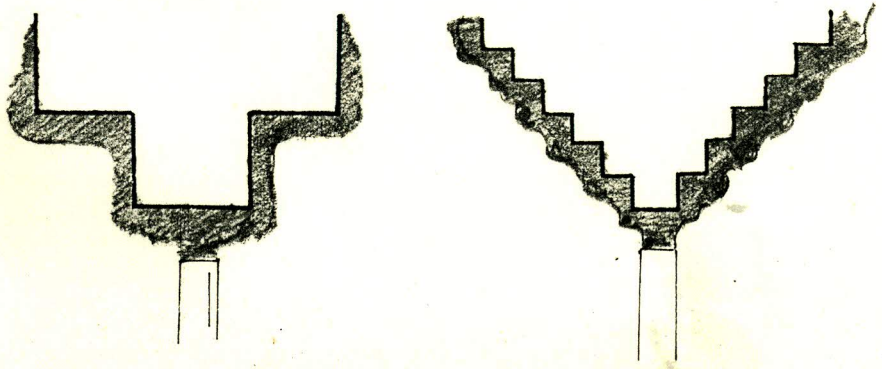
CONCLUSION

Flame follows shortest route on the obstruction's surface to regain it's original vertical upright form.

OBSTRUCTION



FLAME FORM

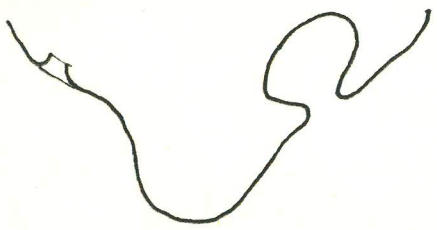


CONCLUSION

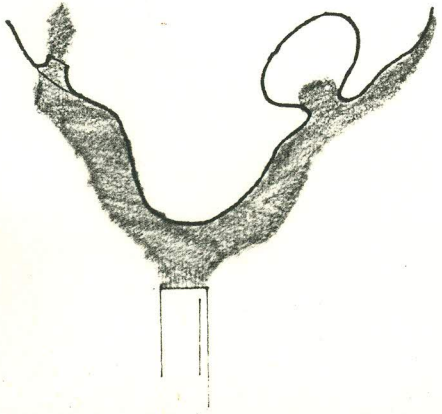
Numerous small steps on a surface creates turbulance in flame but if the steps are big enough to be effective, flame follows the surface smoothly.

The same results were observed with medium and coarser textures.

OBSTRUCTION



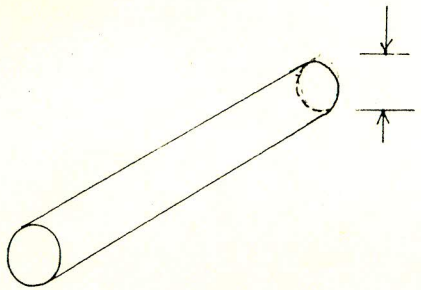
FLAME FORM



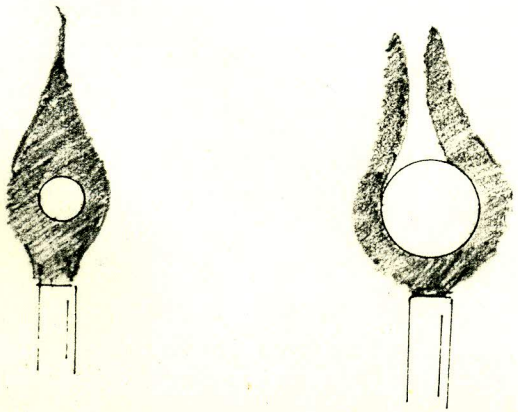
CONCLUSION

Flame drags on a smooth curvilinear surface but through opening it immediately takes it's original vertical form. It never follows negative surface, even if that is in continuation.

OBSTRUCTION



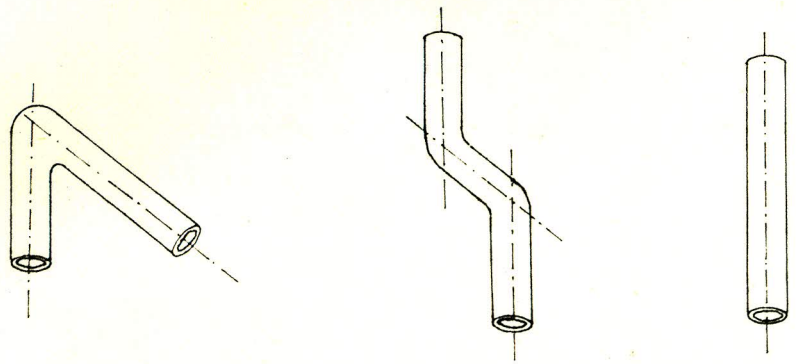
FLAME FORM



CONCLUSION

If the size of the obstruction is less than three times the size of burner (ø) then the flame encircles the obstruction and continues vertically. But if it is more than the flame gets divided in to two parts.

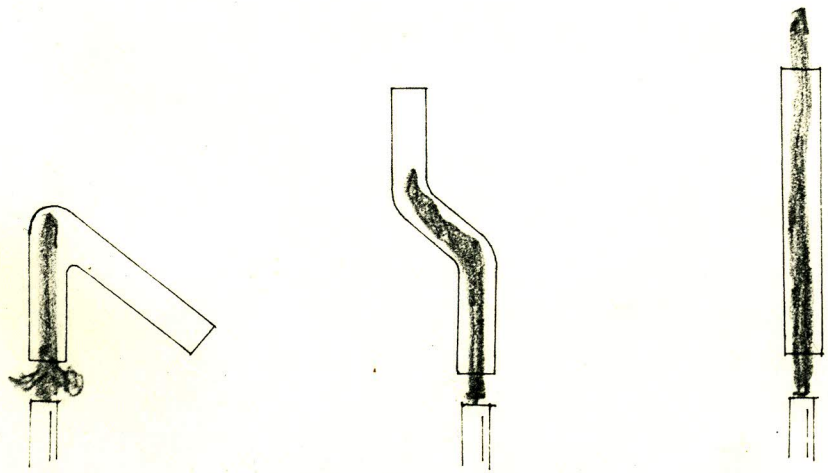
OBSTRUCTION



CONCLUSION

Conduiting of flame through complex bends is not possible. But it passes through a conduit having centre line coinsiding with the centre line of the burner.

FLAME FORM



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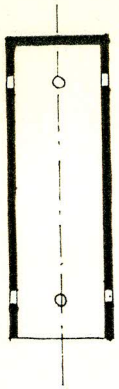
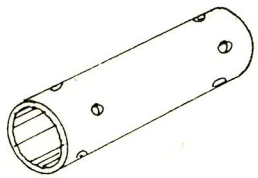
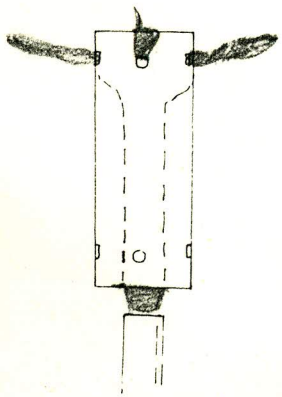




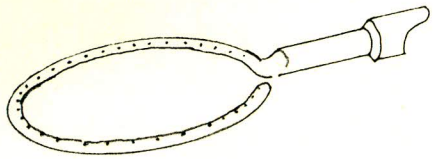
FLAME FORM



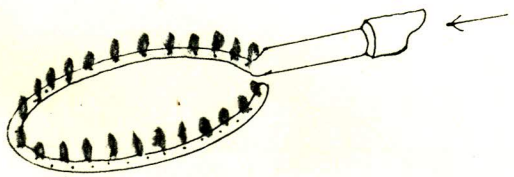
CONCLUSION

Flame conduited through finite space comes out with greater velocity from the tiny orifices near the dead end. It never comes out from pores, away from the dead end.

OBSTRUCTION



FLAME FORM



CONCLUSION

If fuel is made to pass through a sealed end conduit, secondary flames exist at each pore.

Various types of forms are possible by provision of different conduit geometry.

OBSTRUCTION

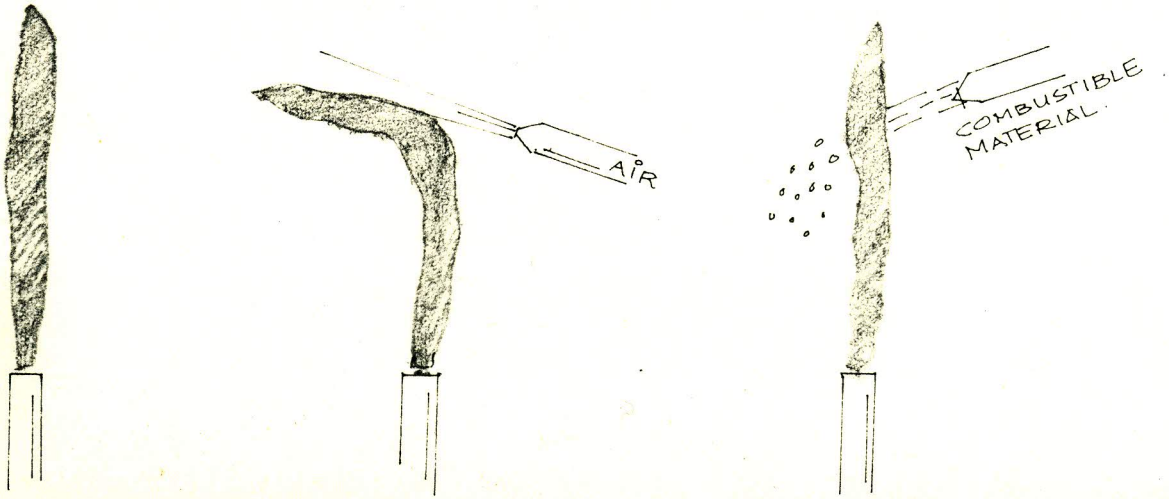
PRESSURISED AIR JET.

CONCLUSION

It's natural form could be changed by introducing air jet with velocity more than the burning velocity of the flame.

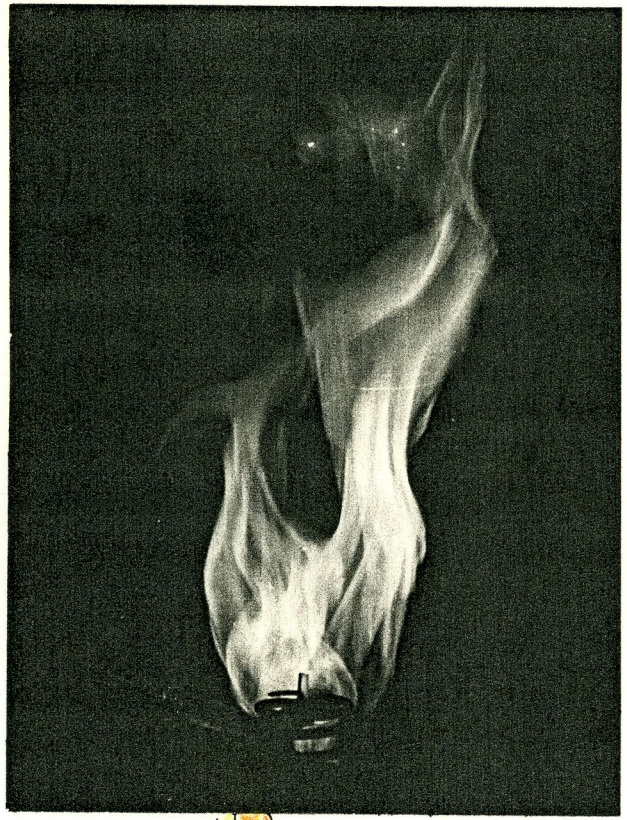
If combustible material, either in form of liquid or powder is sprinkled, it gives out illuminating fire drops.

FLAME FORM



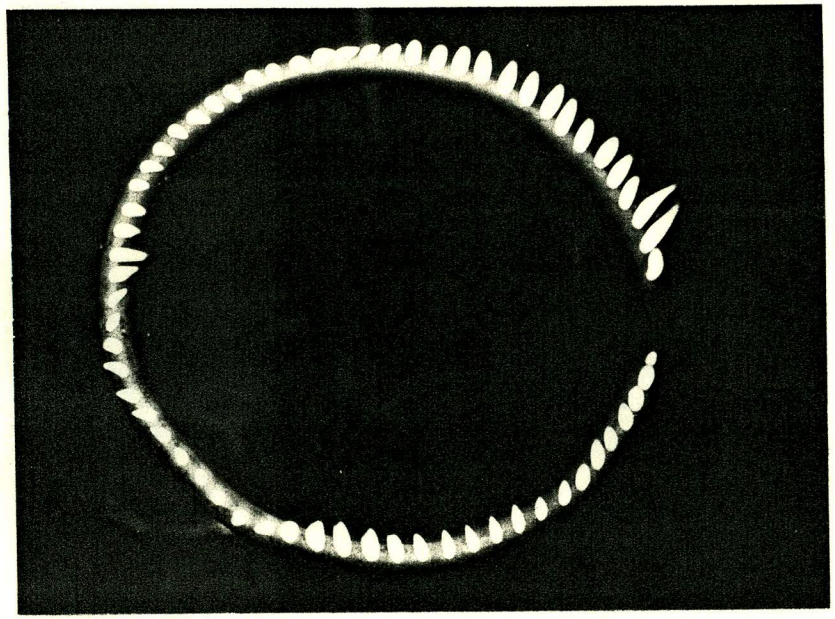
exploration.

FLAME FORM



SET UP

FLAME FORM



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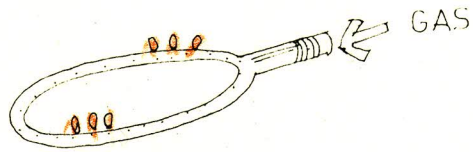

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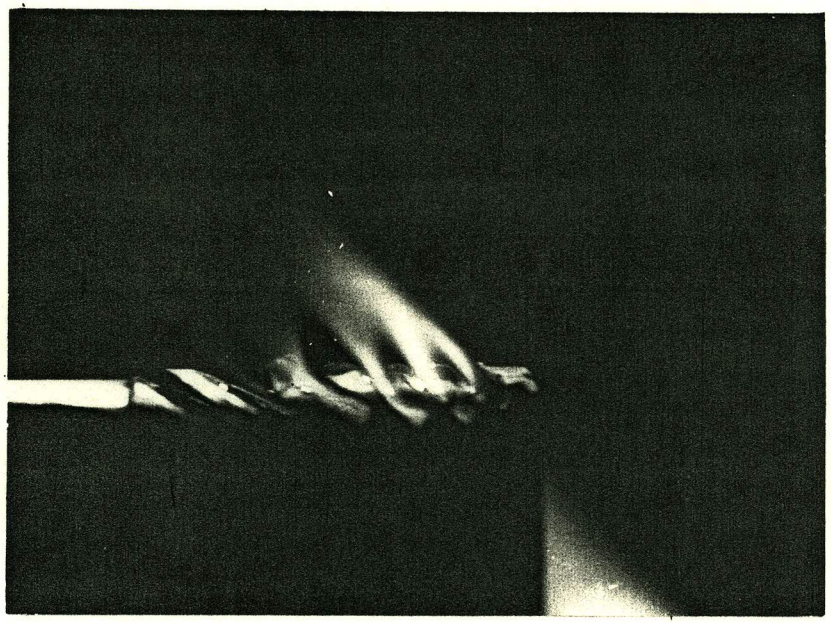

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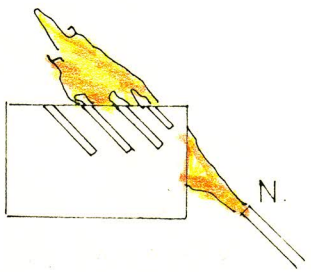

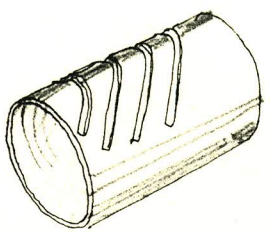

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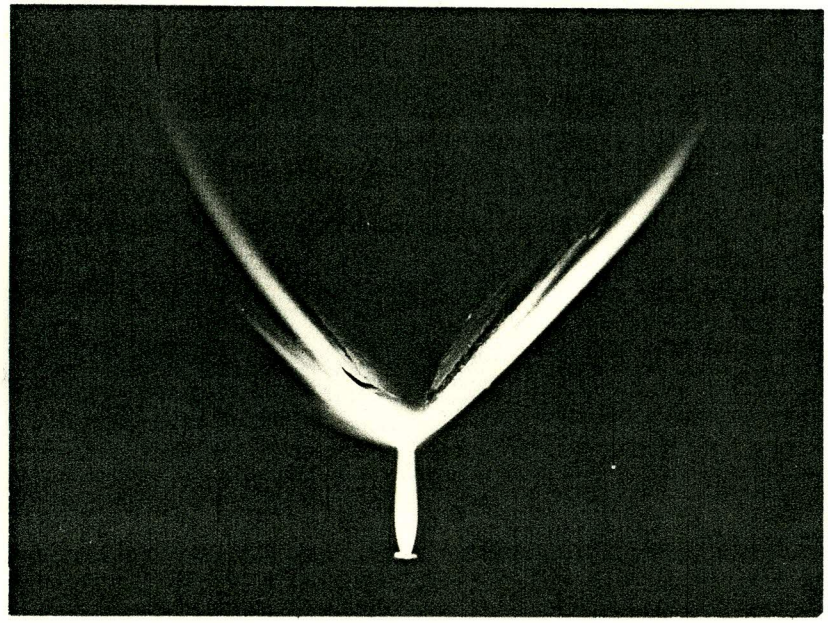

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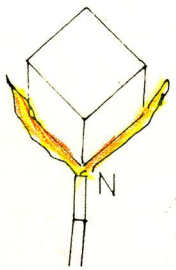

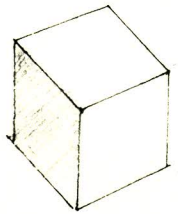

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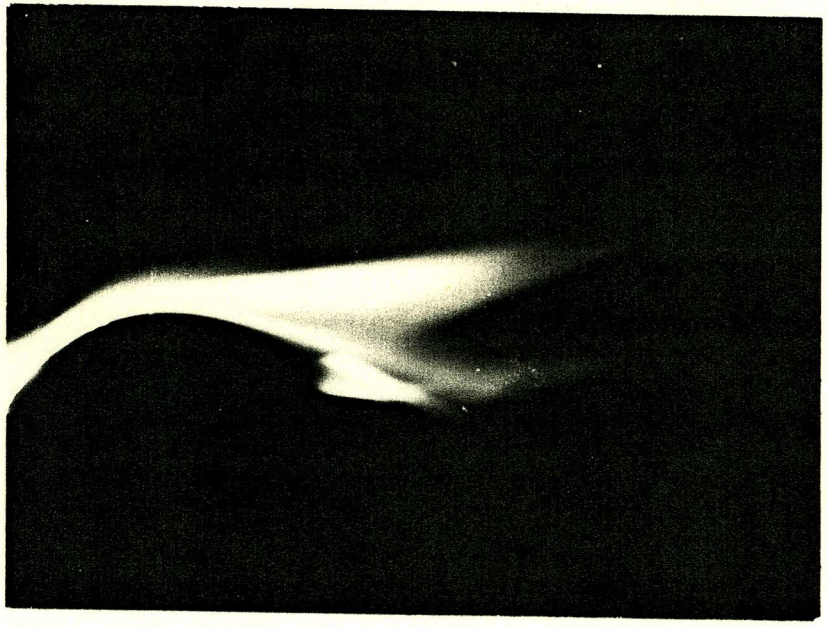

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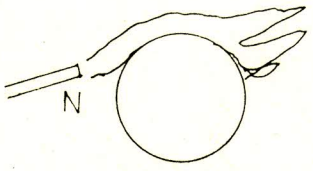

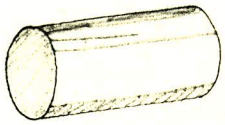

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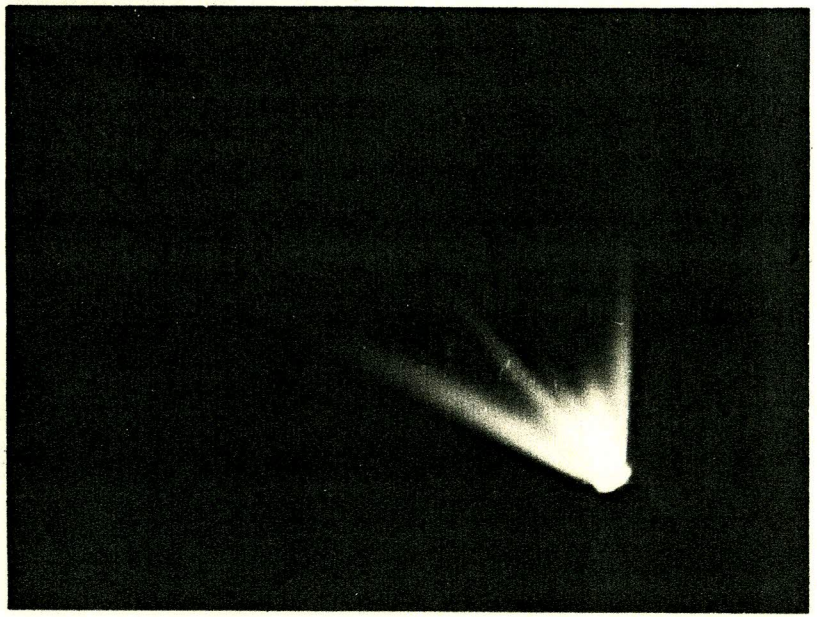

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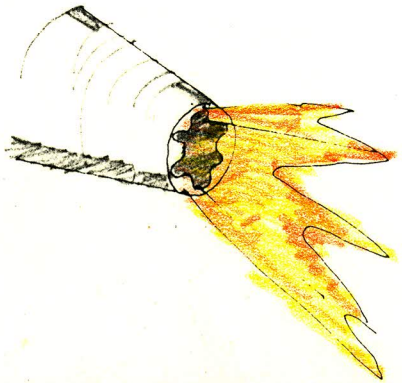

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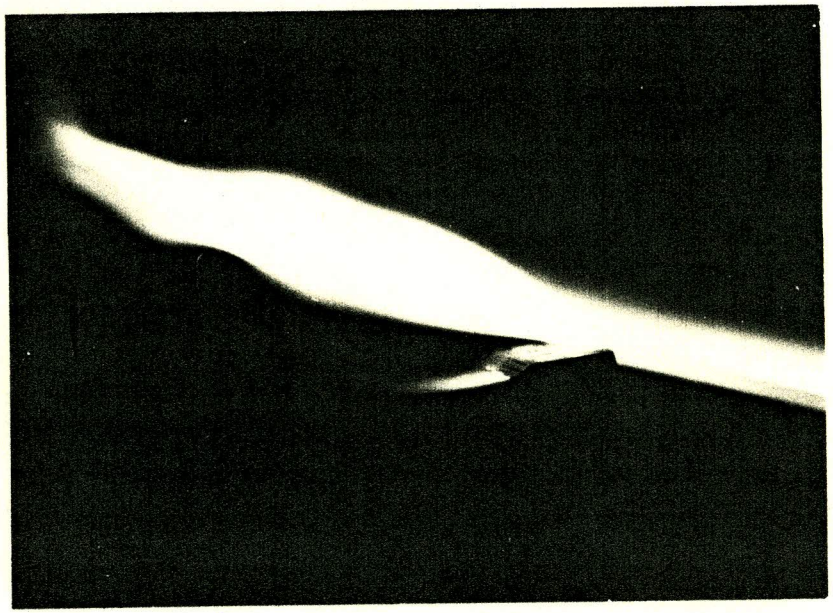

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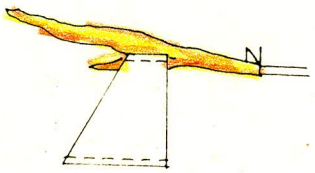

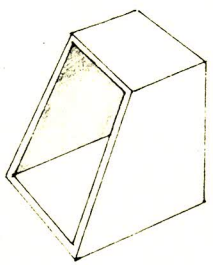

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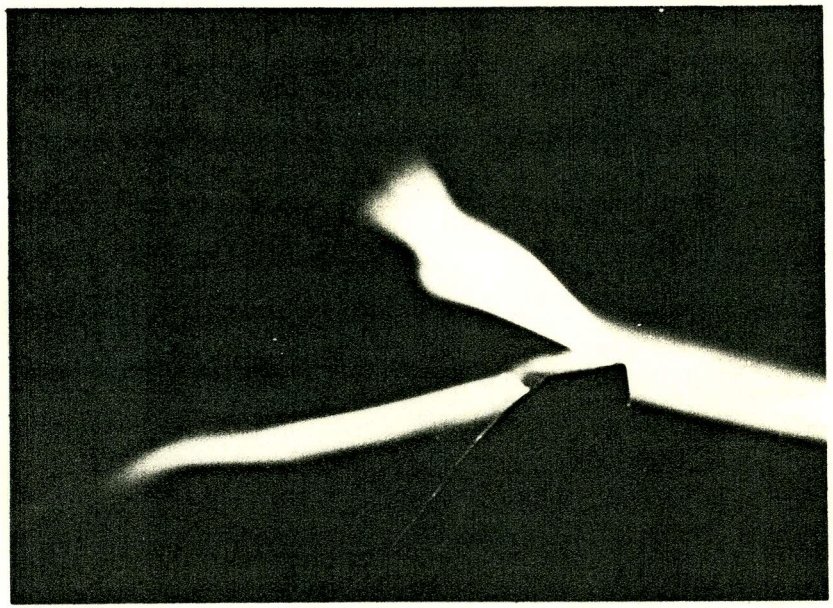

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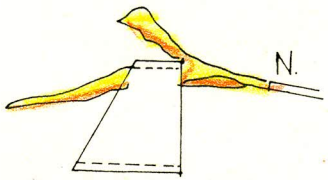

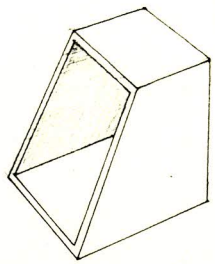

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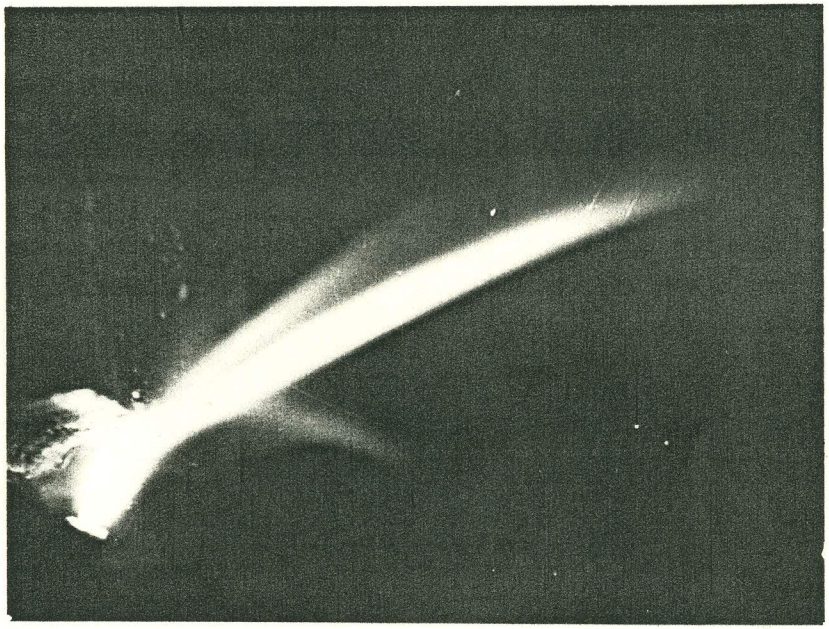
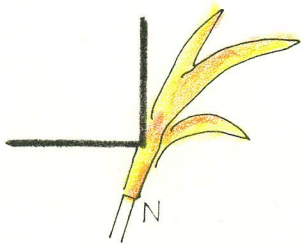


SET UP



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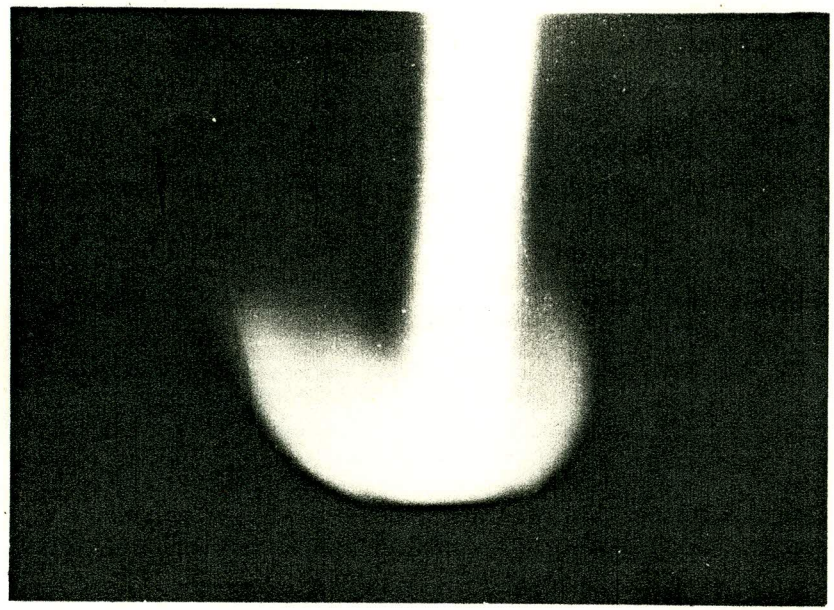

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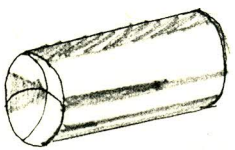

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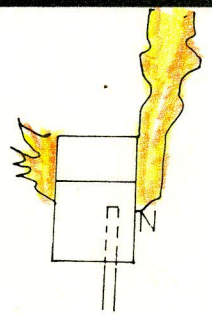

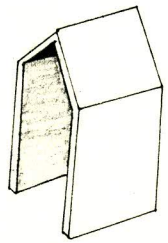

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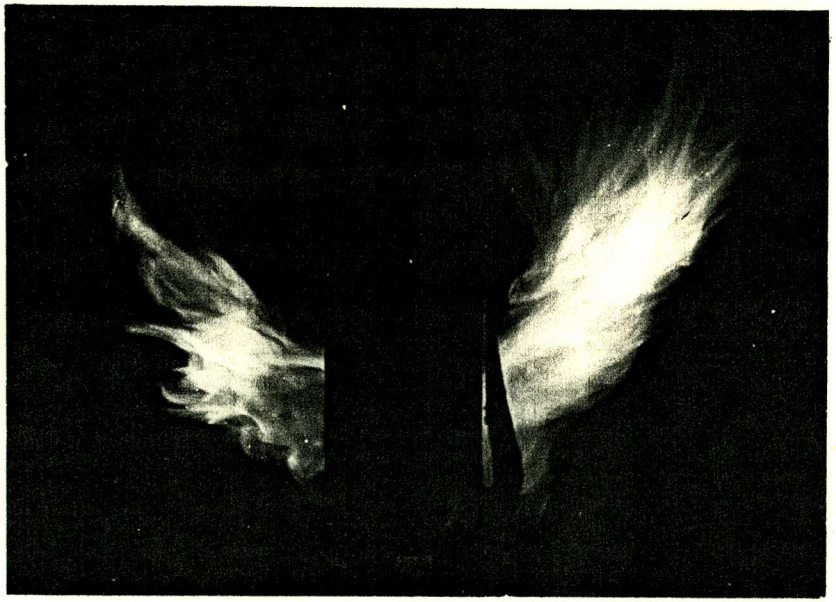

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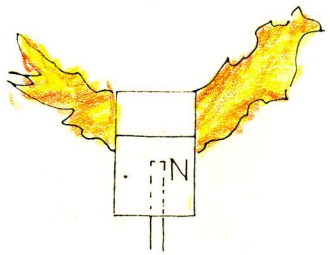

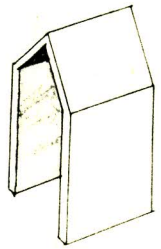

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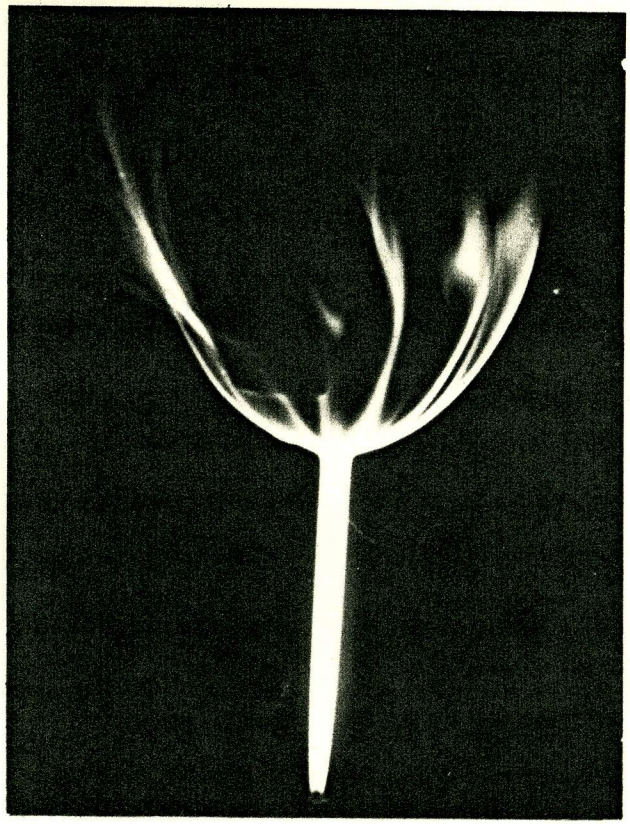

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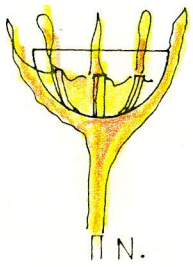

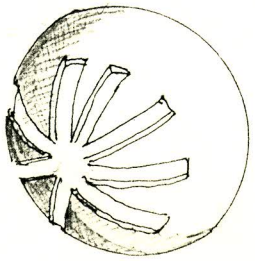

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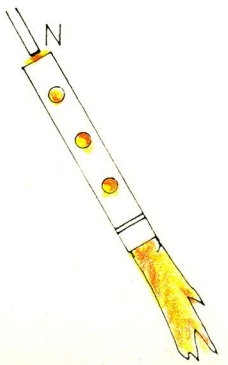

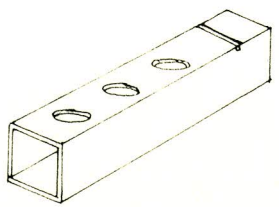

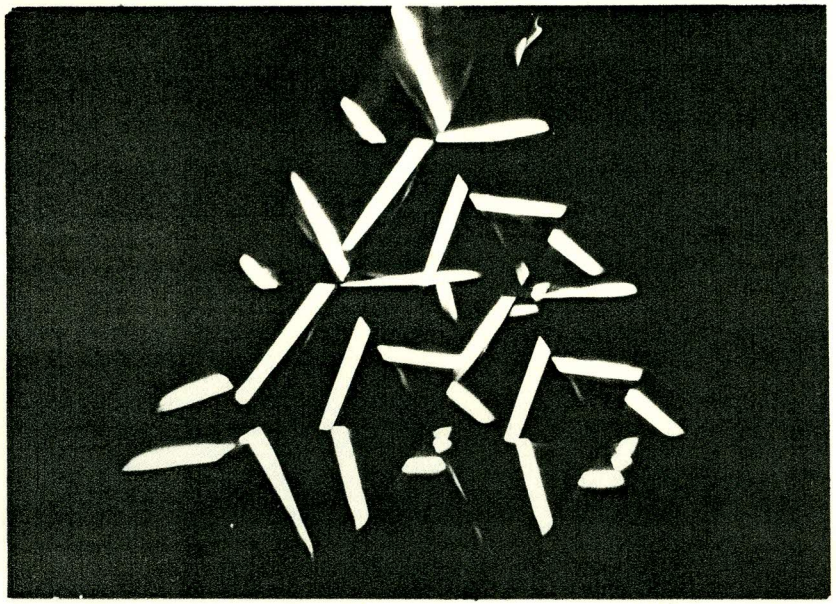

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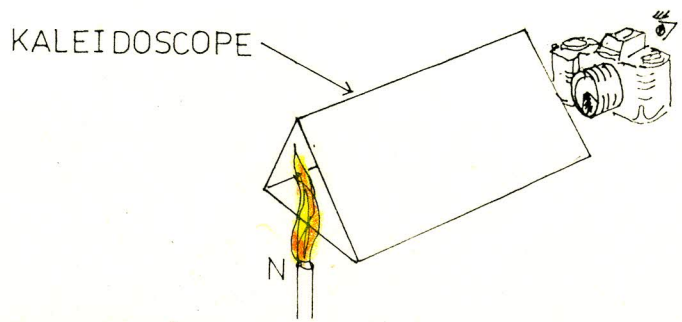

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conclusion.

This project is just a begining in an unexplored medium which has got unlimited potential of exploration. It is therefore hoped that a series of project can be undertaken in future for further exploration to the maximum extent. The results of which may find their applications in variety of fields like

- Design of ornamental lamps.
- Fire sculptures.
- Design of efficient burners.
- Fire gardens . etc.

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