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Exploration Of Water-forms

by

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guide

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Bombay.

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APPROVAL SHEET

The seminar project entitled 'Exploration of water forms' by Rajan Vernekar is approved in partial fulfilment of the requirements for M.Des degree in Industrial Design.

Signature	Date
Guide	20.7.87.

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WATER FORMS

It seem a bit strange when one says ' water forms' because water has neither color nor does it have a fixed shape like metals, plastics or wood.

But still water can express itself in many ways. It can be as silent as a dew drop or as restless as the turbulent seas. Though it has no color, water can borrow from it's surroundings and make it's presence felt. By reflection, water can add a whole new dimension to the environment.

Since ancient times water has played an important role in the life of a man. From utility point, man has used water for drinking, washing, irrigation, power generation etc. On the aesthetic side he has used water in things like fountains.

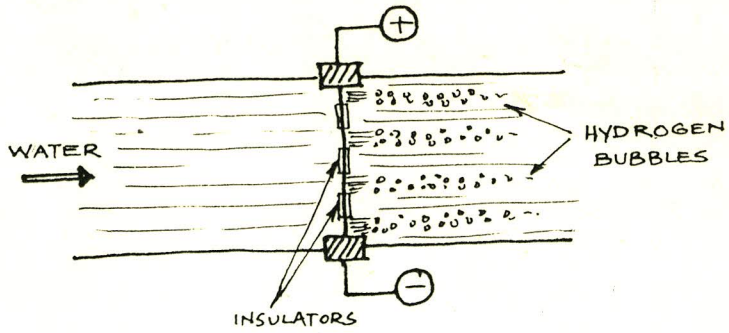
The Japanese seem to have a high level of understanding of water which,

is reflected in their gardens.

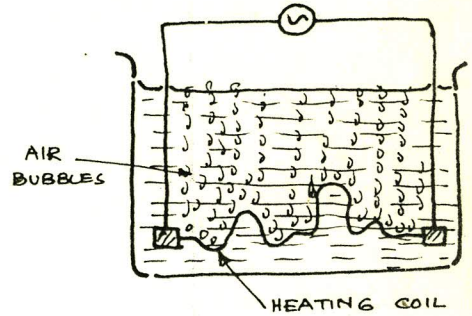
Mine, is an attempt to make an organised study of water forms and to classify them. This study is by no means exhaustive and is open for further exploration. As a designer, my aim here was not to make an in depth study of individual forms, but to open up doors for anybody in search of new possibilities in this field.

TECHNIQUES AVAILABLE FOR EXPLORATION

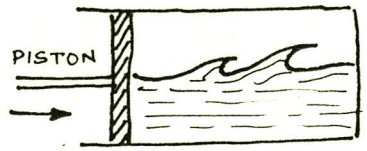
a. Electricity - A conducting wire is placed across the flow of water. Whereever it touches water, hydrogen bubbles are released which, flow with it. By varying the contact area or by changing the shape of the conductor, different patterns are possible.

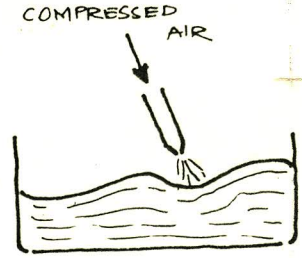


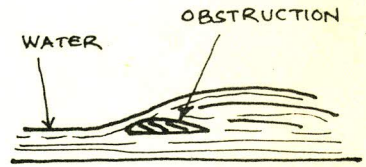
b. Heat - A heating coil, when immersed in water releases bubbles. By changing the shape of coil and the temperature it is possible to get different patterns. Addition of acetone to water accentuates this effect.



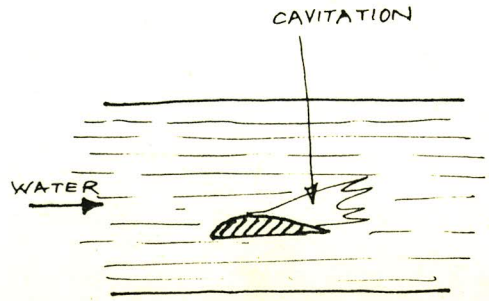
c. External Disturbance - It could be mechanical force (ex.piston) compressed air, obstruction, or sound waves. Such disturbances can create different kind of patterns in the liquid.

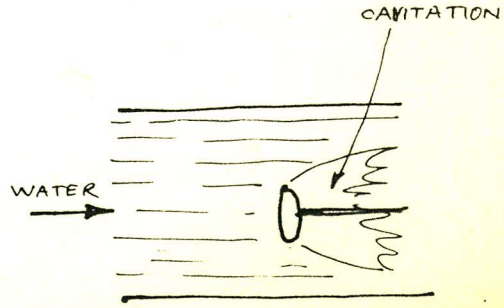




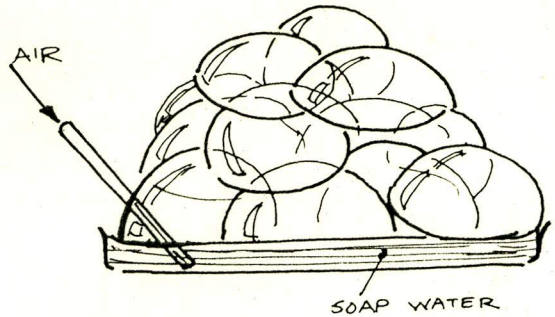


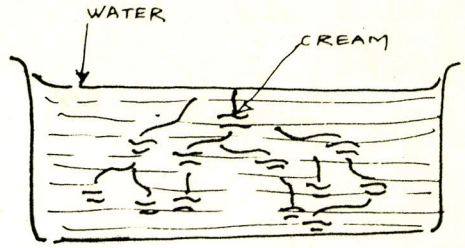
d. Cavitation - When a solid obstruction is kept in a fast moving liquid, cavitation occurs which, unfortunately can be seen only with stroboscopic lighting or high speed photography.





e. Chemical Additives - When air is blown in soap water, beautiful bubbles are formed. Similarly when cream is added to water, it creates fascinating flowing patterns. Many such things are possible with different chemicals.





f. JETS - All the above mentioned techniques need elaborate setups. Also, in all these cases there seems to be a barrier between water and the designer. In case of jets water exists in a form with which we are all familiar. We can see and feel water as water and not something else. So I have chosen jets for exploration.

EXPLORATION :

I went about exploring water forms more like an artist would i.e.by getting a feel of the medium rather than beginning with mathematical equations which is verymuch possible.

I started with a single hose and started 'playing' with water just to get a feel of it. Then I introduced obstructions of all shapes - regular, irregular, crystalline, amorphous. Slowly I began to see a relationship between the form and the obstruction and was able to classify them.

Wherever I felt, a particular kind of nozzle/obstruction did not produce ~~substial~~ substantial difference in existing form, I have skipped it. Also whenever a minor manipulation in the shape of the obstruction made pronounced difference, I have included it.

Every 'water form' shown in this report, if necessary, can be

CLASSIFICATION :

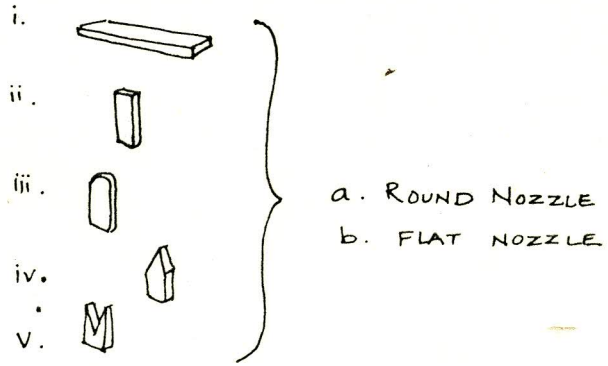
1. FREE JETS

   i. SINGLE JET

   ii. MULTIPLE JETS

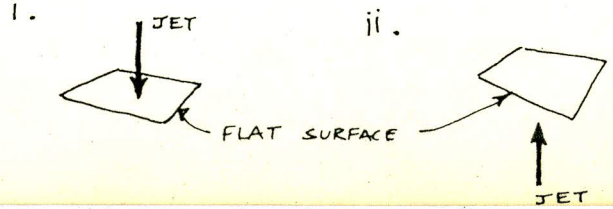
2. JET + SOLID-EDGE

TYPES OF EDGES



3. JET + CURVED SURFACE

4. JET + FLAT SURFACE



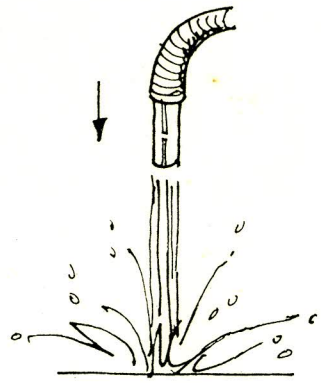
supported by exact mathematical relationships. In case someone wants to do an indepth study of each 'form', it can be done with the help of an expert from the field of 'fluid mechanics' because only such a person can do justice to the subject.

1. JET + GRAVITY

Only free jets were used and the variables were - direction of jet, number of jets and diameter of nozzle.

Single Jet

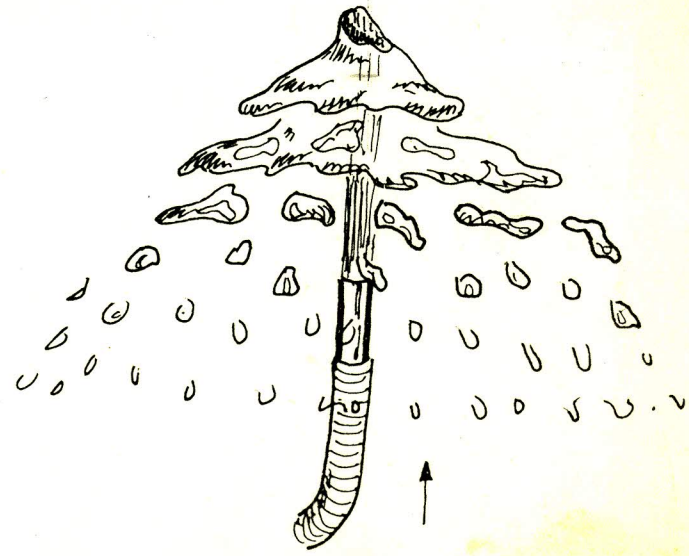
a. Here water force and gravity are acting in the same direction. The jet comes down in a straight path.



1. a.

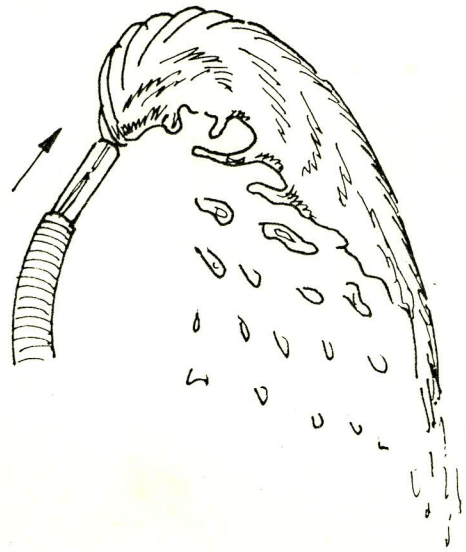
b. The same jet is now pointed vertically up and made to fall back on itself. Water force and gravity are acting against each other. The jet breaks up into layers, progressively expanding till they terminate in the form of droplets.

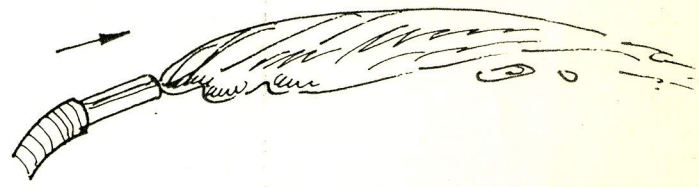
This creates an interesting pattern which unfortunately is very unsteady. It can be seen only on careful observation or recorded by high speed photography.



1. b.

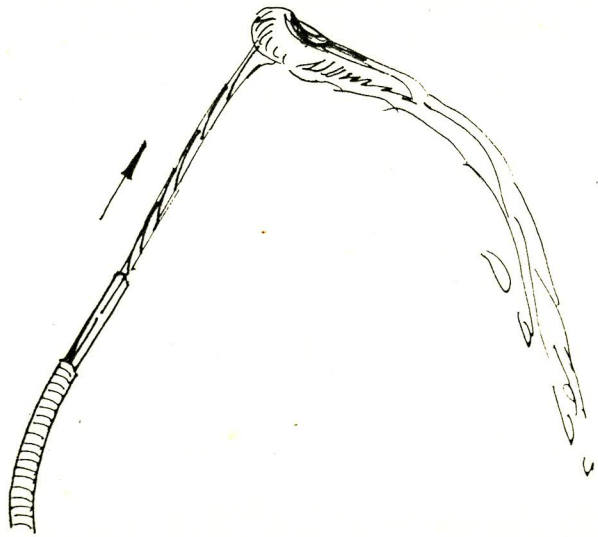
c. The jet is tilted at an angle to the vertical. Two forces are acting on the jet. - Water pressure which tries to throw it outward and gravity which tries to pull it down. As a result, the jet follows a parabolic path. The jet breaks down into 'tongues' of water which progressively break into droplets. As the direction of jet becomes more and more ~~steady,~~ horizontal, it becomes steady.





1. C.

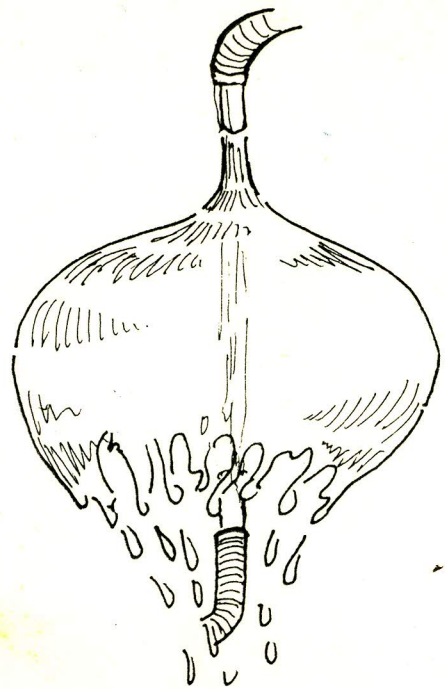
d. It varies from 'c' only in the diameter of nozzle. Due to variation of proportion of jet diameter to jet length, the form looks quite different. Otherwise it is same as 'c'.



1. d.

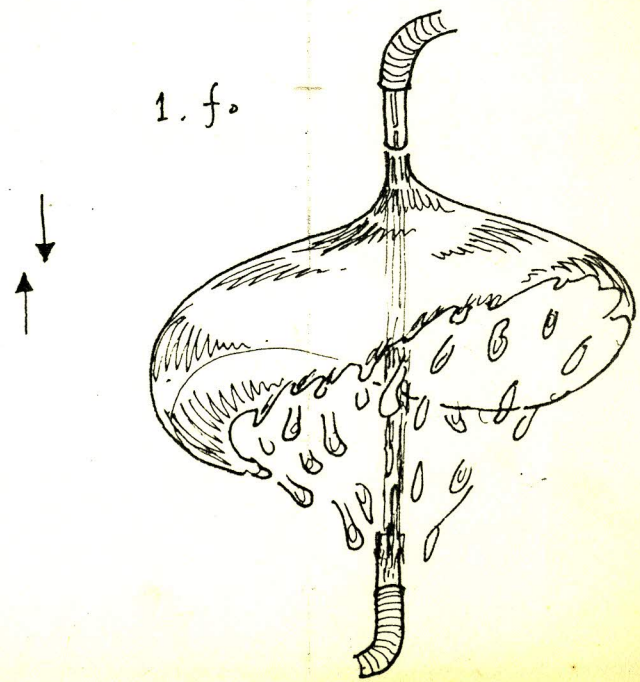
Multiple Jets

e. Two jets of equal diameter, one pointing vertically up and the other vertically down are positioned axially. At the intersection of jets, water spreads out into a thin film, resembling an umbrella. Just by varying the distance between the jets, the umbrella shape transforms into a bubble. Size also can be varied by varying the jet size. Just by using 1 cm jet I was able to get a bubble of about 45 cm. in diameter.



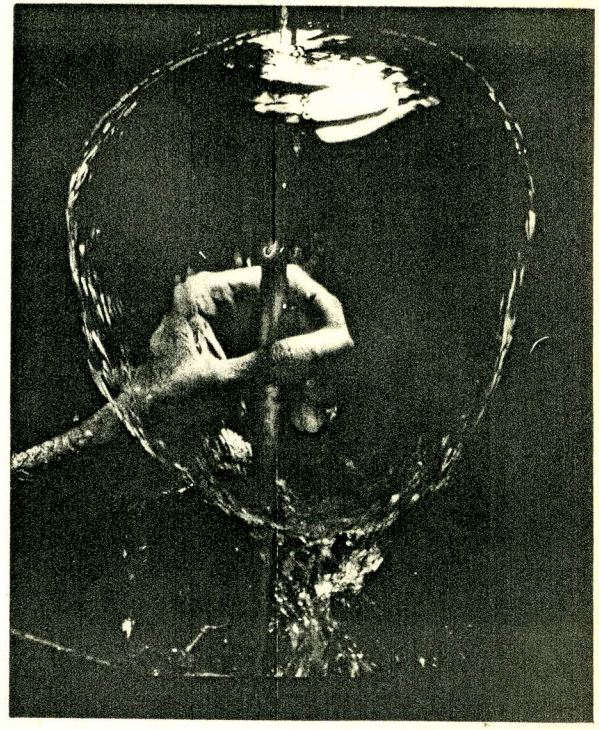
1. e.

f. If the axis of one of the jets is shifted, a nice wobbling effect can be got. So if one jet is rotated in a concentric circle about the other, a continuous wobble is possible.

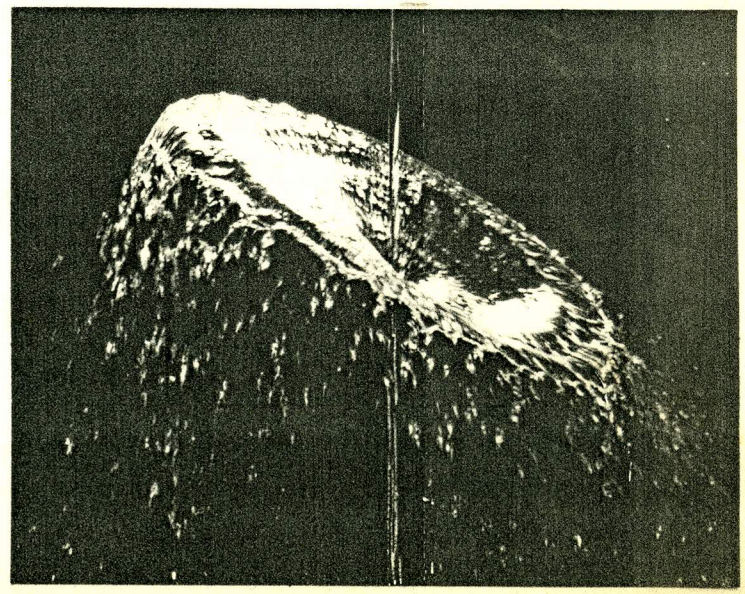


1. f.

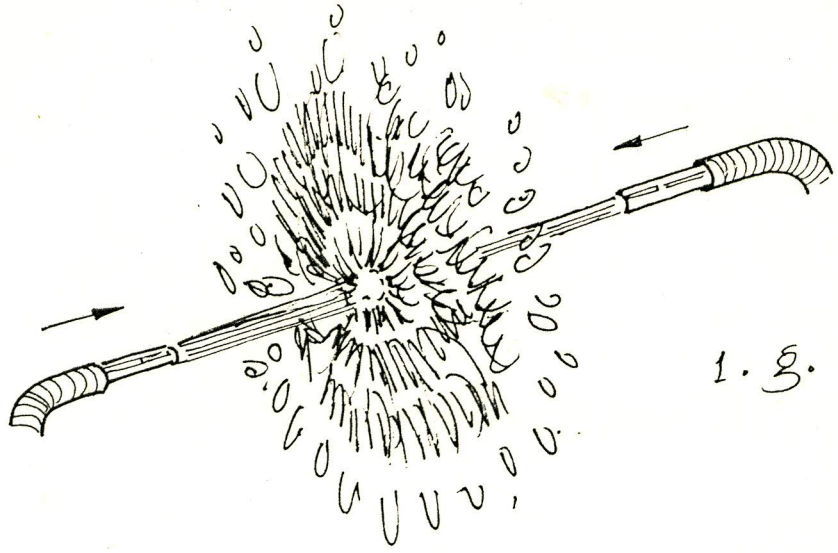
Ref. 1.e.



Ref. 1.f.

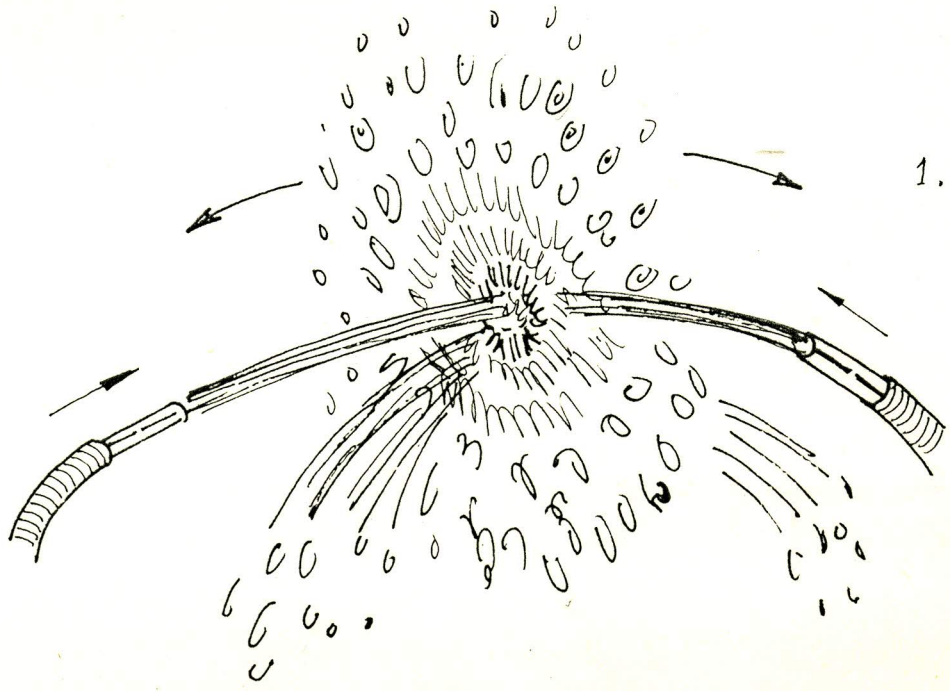


g. Two jets of equal diameter kept axially are made to intersect in a horizontal direction. Water spreads out into a thin film to form a beautiful disk.



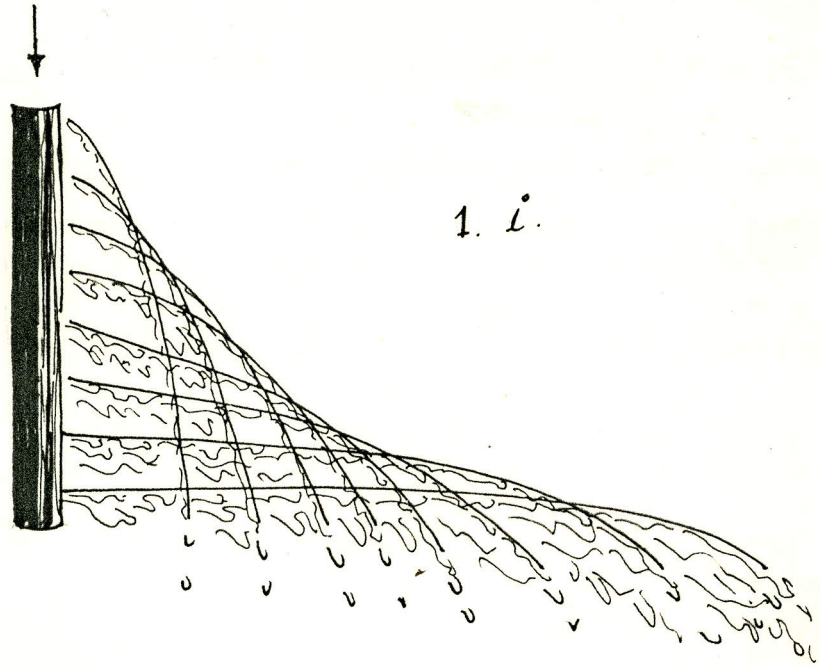
1. g.

h. Now if the same jets are placed as shown in fig. to form an arc of a circle, the disk of water starts oscillating between the two jets continuously.



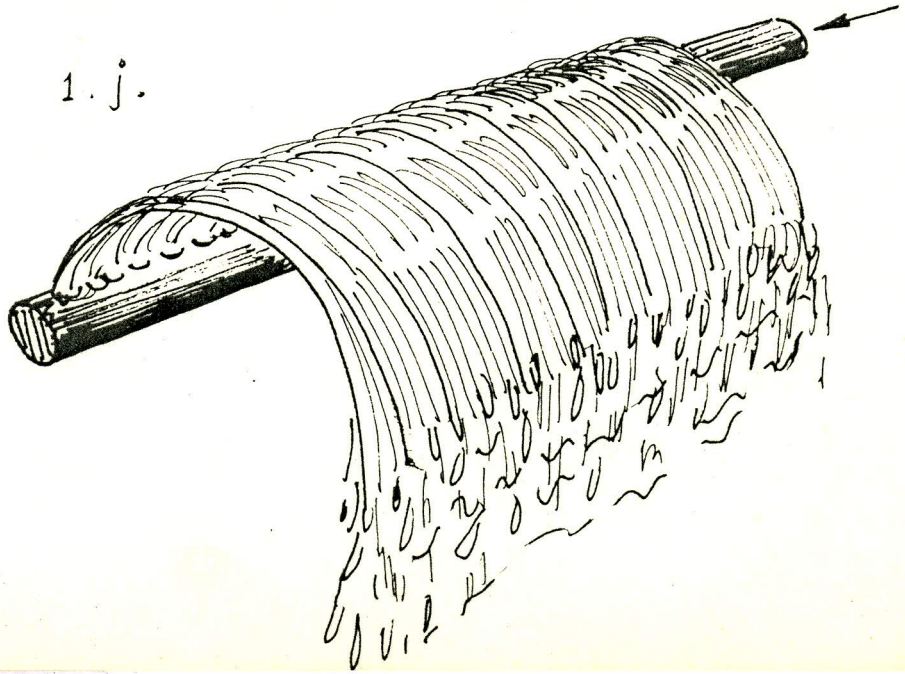
1. h.

i. This is a simple set up used to explain Bernoullis principle. A straight length of pipe is closed at one end and drilled at equal distance on its length. Water is let in at the other end.
Different patterns can be created depending on whether the pipe is kept vertical, horizontal or inclined. The paths of water are different corresponding to pressure at that orifice. As the height of water column increases, pressure increases.



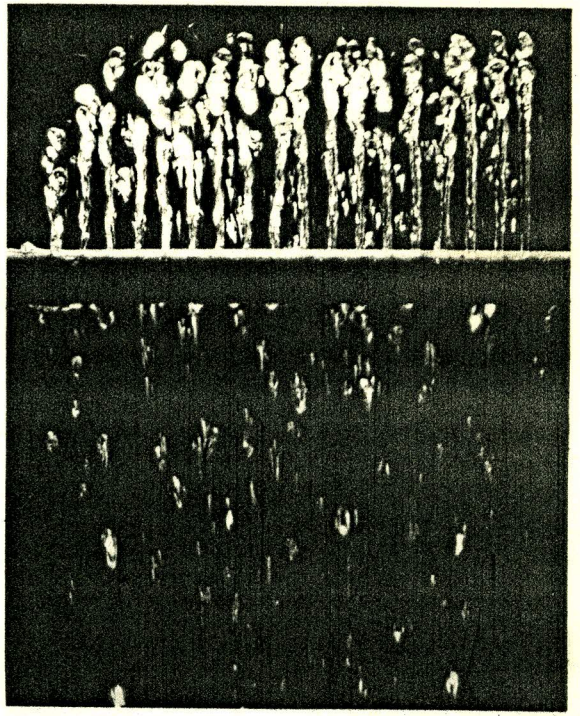
1. i.

j. All jets trace the same path because the pipe is horizontal and all orifices are at the same pressure.

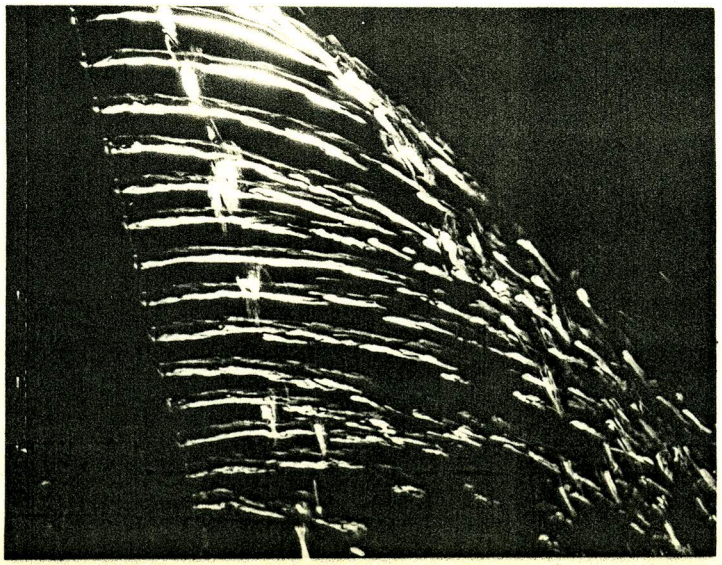


1. j.

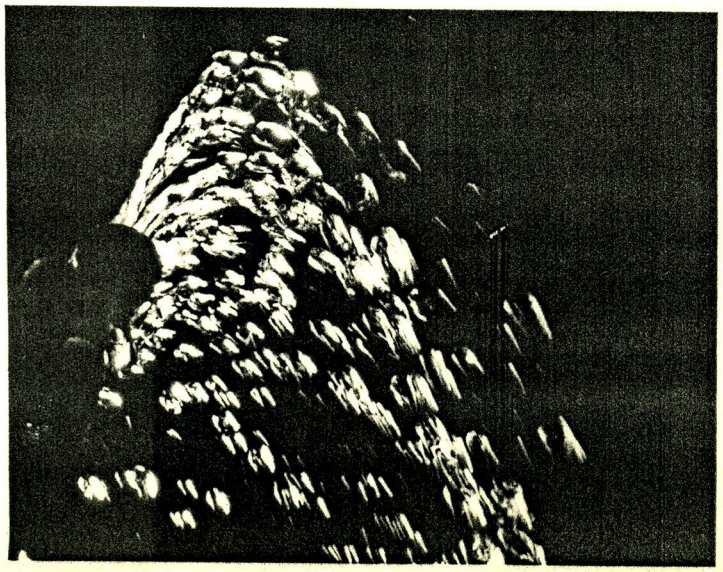
Ref. 1.j.



Ref. 1.i.

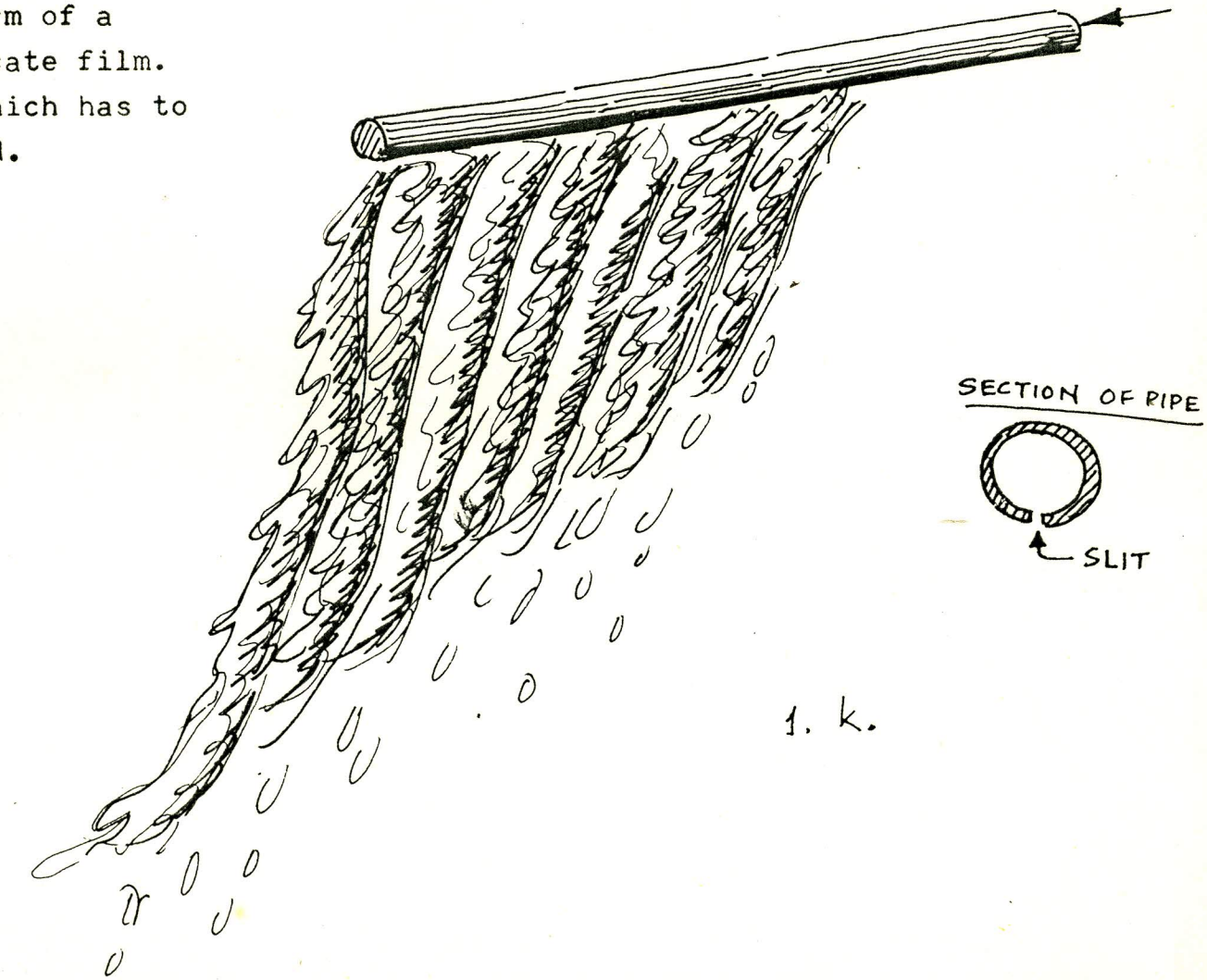


Ref. 1.j.



k. A thin slit is made along the length of a straight pipe. The pipe is kept horizontal. Water is let in at one end and the other end is closed.

Water comes out in the form of a continuously moving, delicate film. It is one of those form which has to be seen live to be enjoyed.

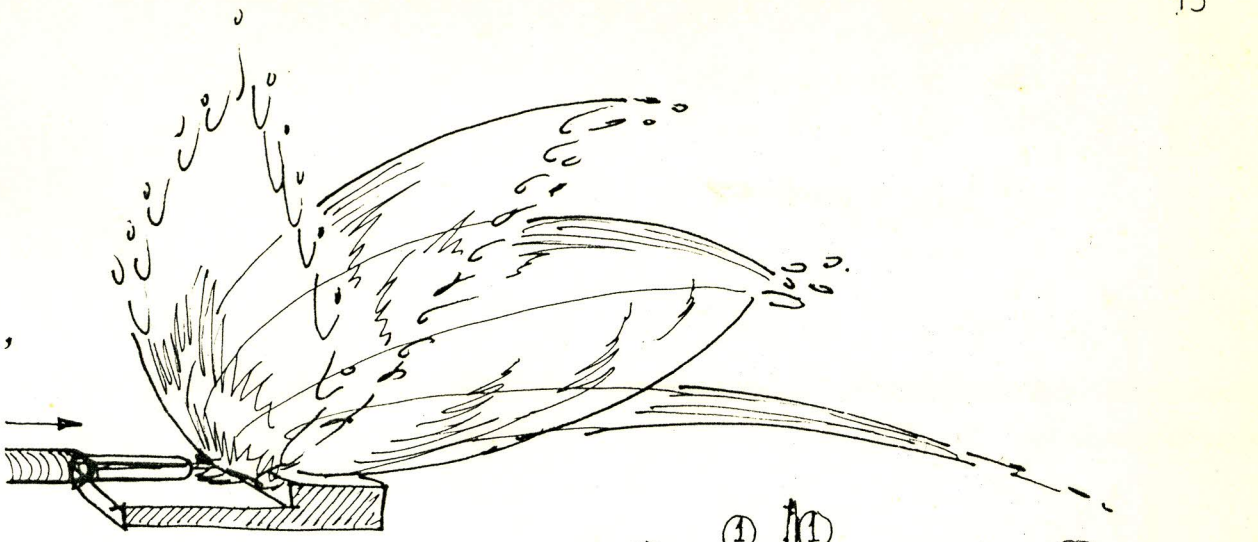


1. k.

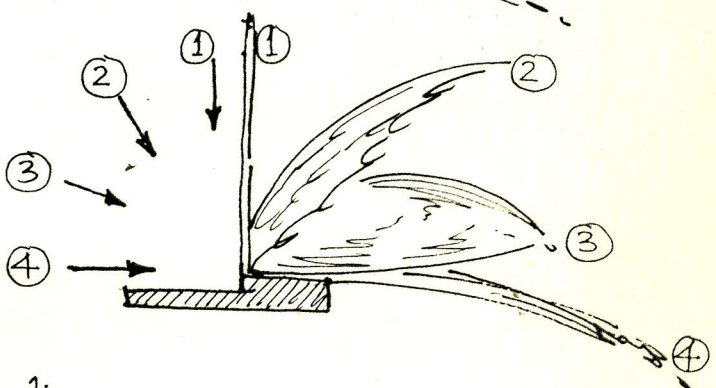
2. JET + EDGE

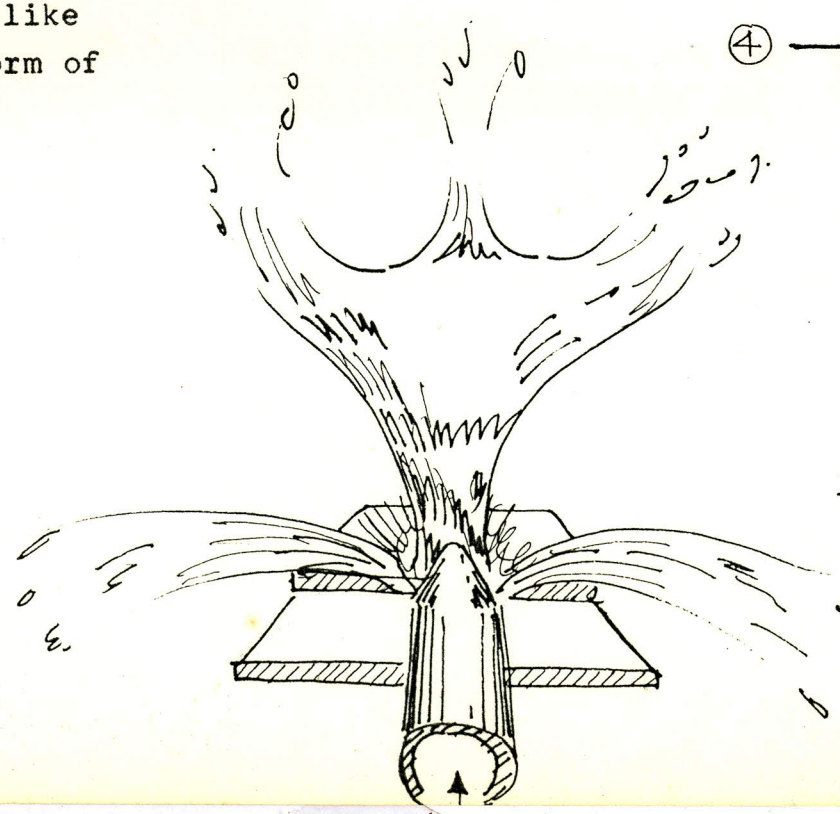
A straight edge was used as obstruction. Diameter of nozzle and pressure were kept constant. By just varying the position of jet, different forms were obtained as shown in 'a'

b. Instead of the normal round nozzle, a flat nozzle as shown in figure was used and the same procedure was repeated. Flat nozzle gives a nice flame like form unlike the rounded form of 'a'

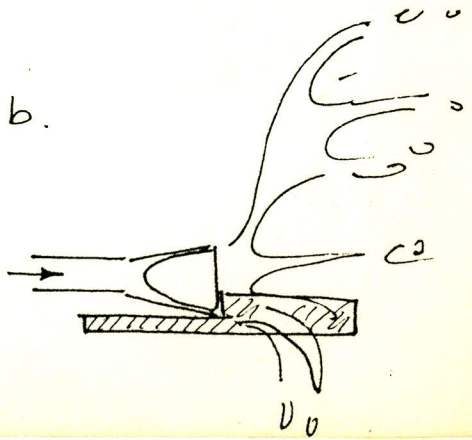


2.a.

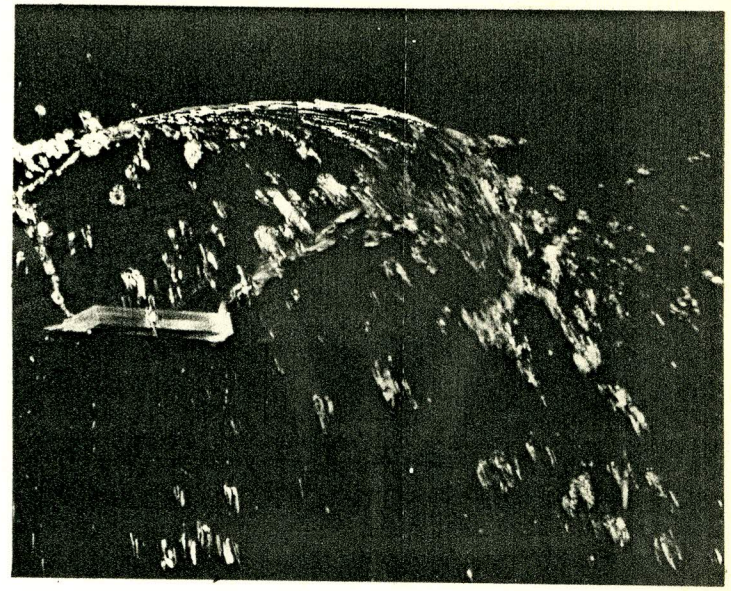




2.b.



Ref. 2.a.



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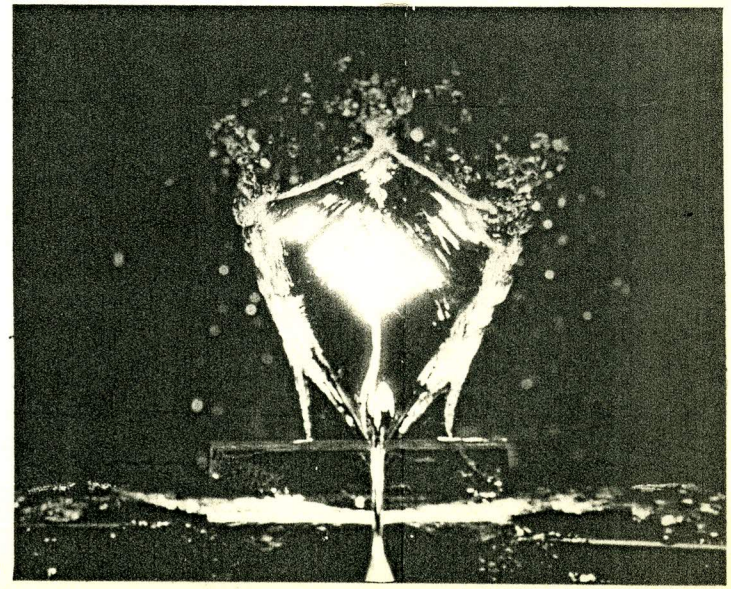
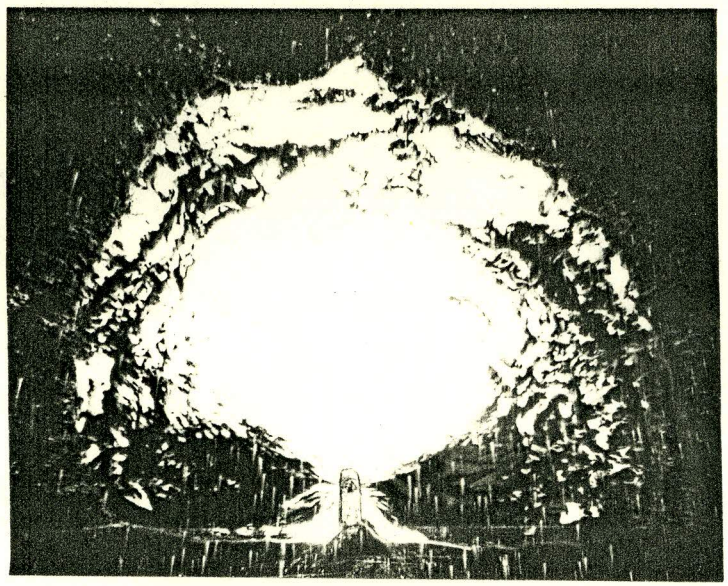
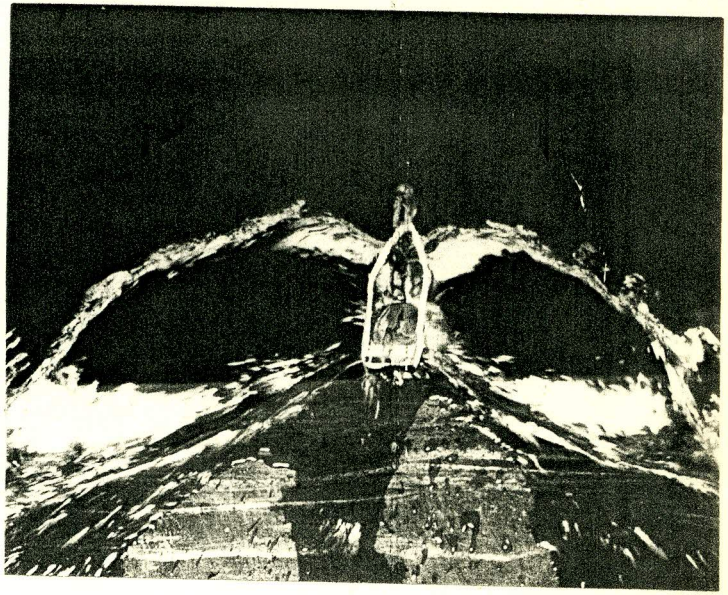
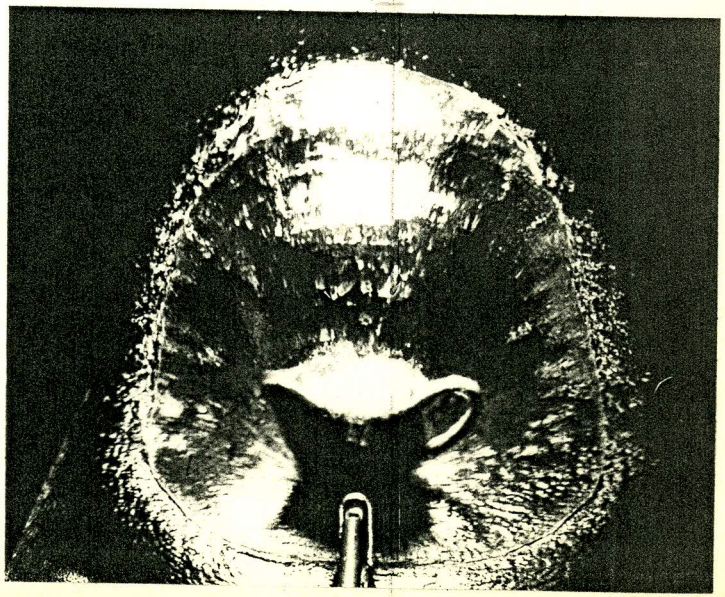






These forms were obtained by replacing the straight edge  by modified versions like

i.  and ii. 



3. JET + CURVED SURFACE

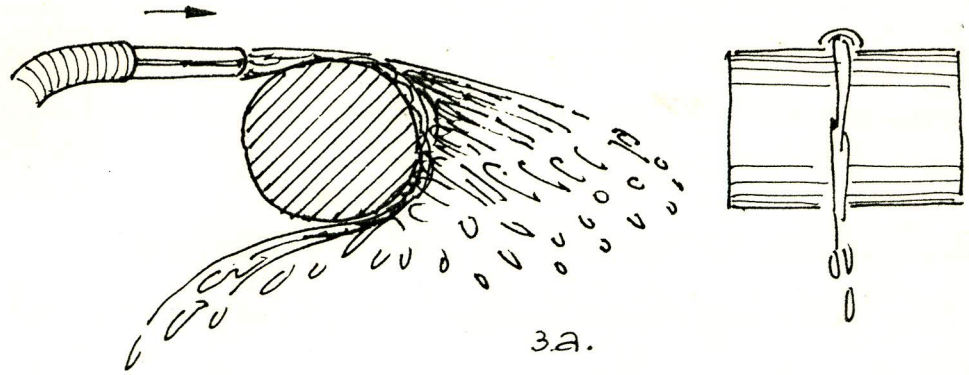
A cylinderical surface was used as obstruction. Position of jet was changed to get different forms.

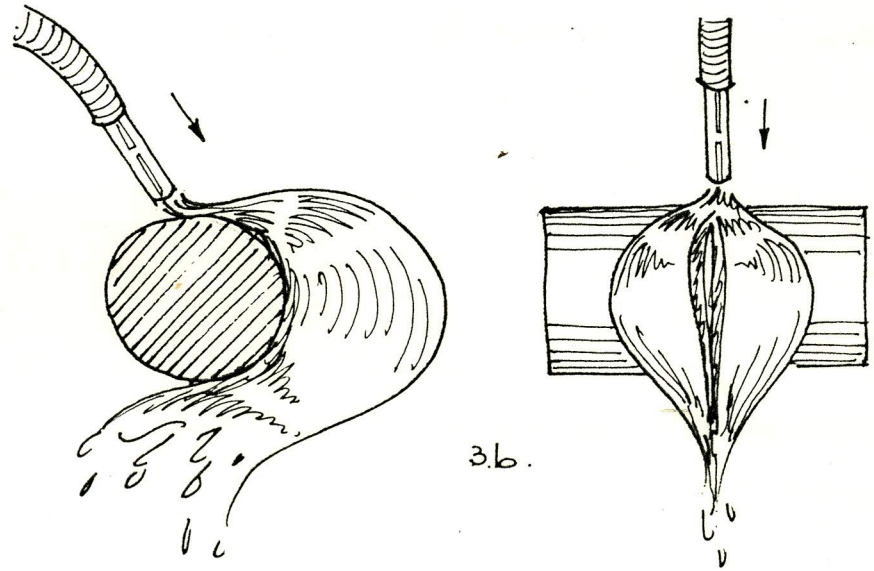
a. The jet is placed tangential to the cylinder and perpendicular to its axis.

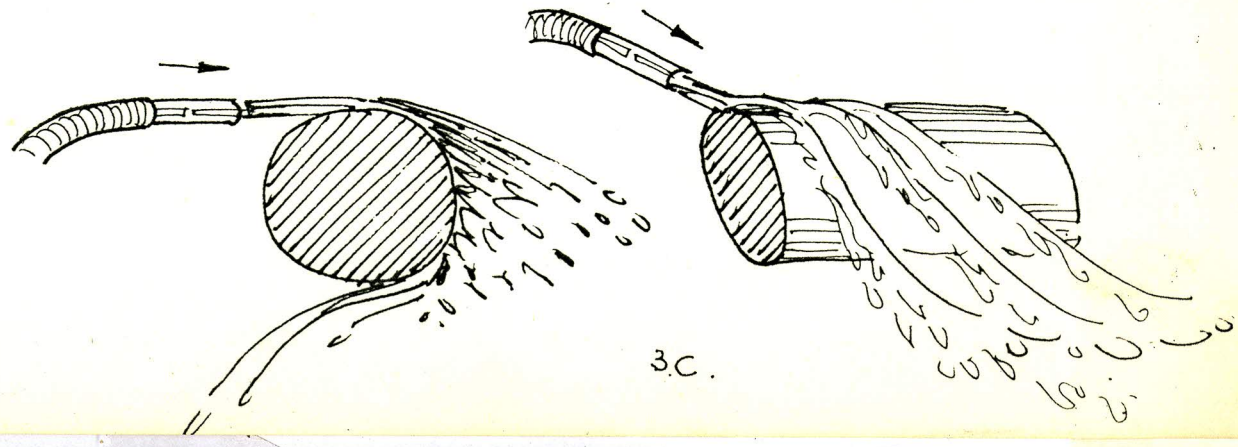
Water spreads out in the form of a film, droplets are thrown out ina radial direction.

b. As the jet moves from tangential to a radial direction, jet changes from film to a bubble.

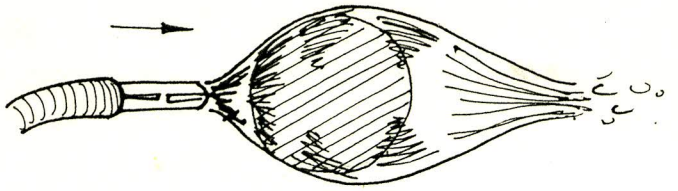
c. And when the jet is kept tangential but impinges at an angle other than 90°, the single film breaks up into a number of helical films.

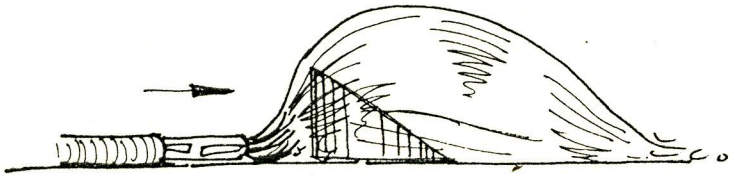




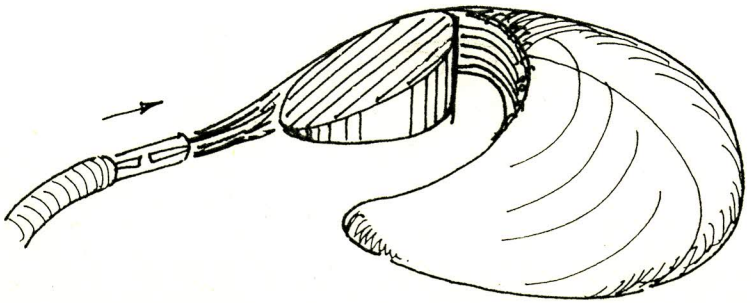


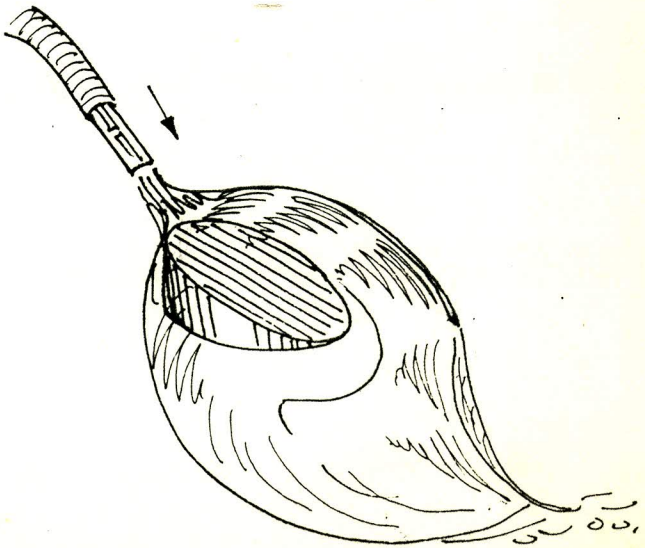
d. Now the same cylinder is chopped to form the shape shown. By varying the position of jet various forms shown are possible.



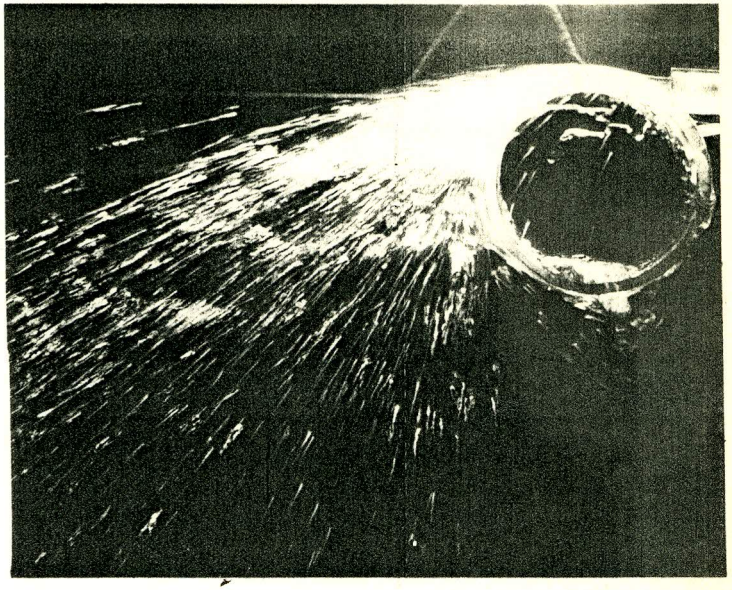


3·d.



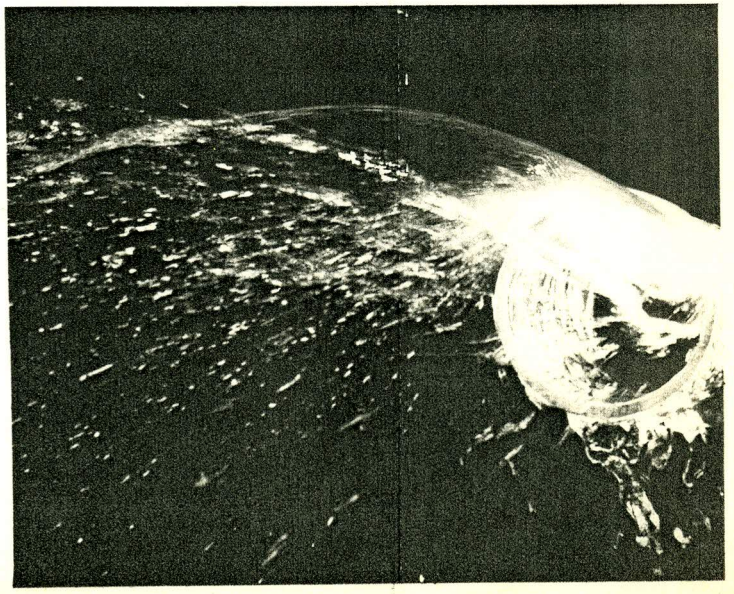


Ref. 3.a.

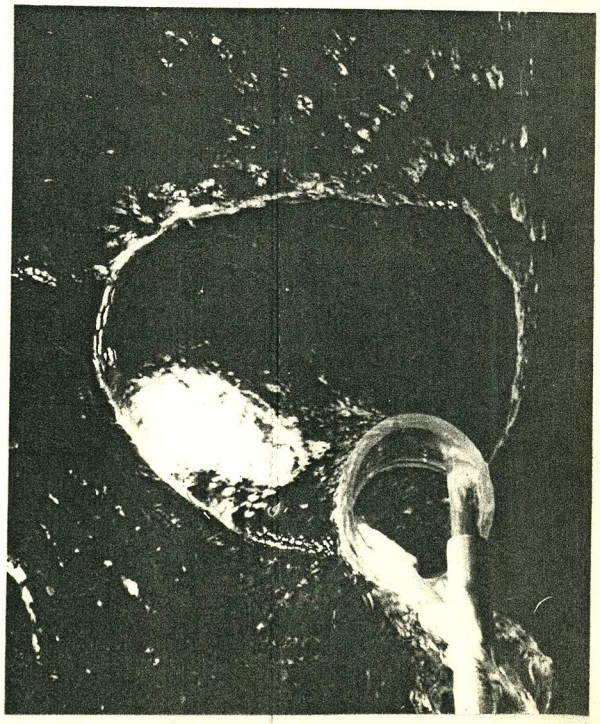


Ref. 3.b./3.C.

This is a combi-nation of 3b & 3c as the jet is kept at an angle >90° to the axis and is also radial in position.



Another variation
of 3.d.



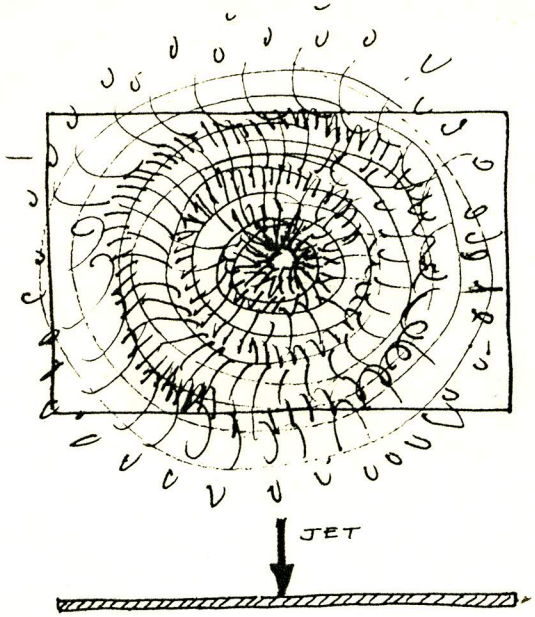
4. JET + FLAT-SURFACE

In this case flat surface forms the obstruction.

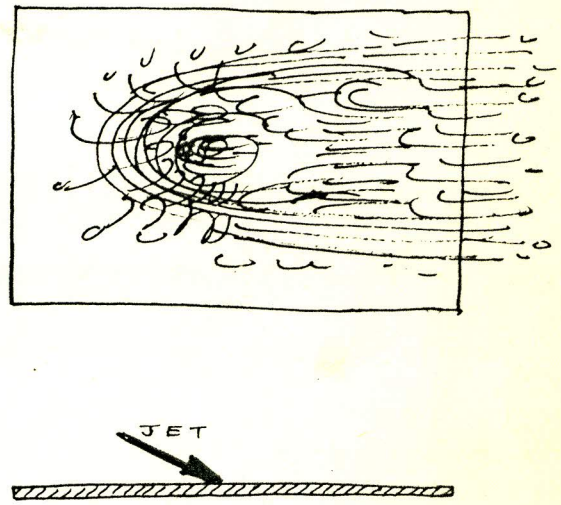
a. Jet was made to impinge on an acrylic sheet to get the radial lines.

b. In this case the jet impinged on a coarse sand paper. It's texture breaks the radial lines into a regular geometric pattern.

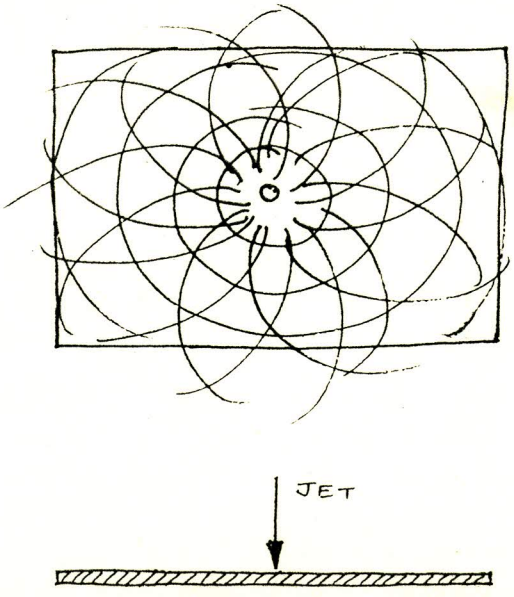
c. Deep scratches were made on an aluminium sheet. Water started to radiate from these scratches. So it is possible to control the depth and shape of scratch to get different patterns.



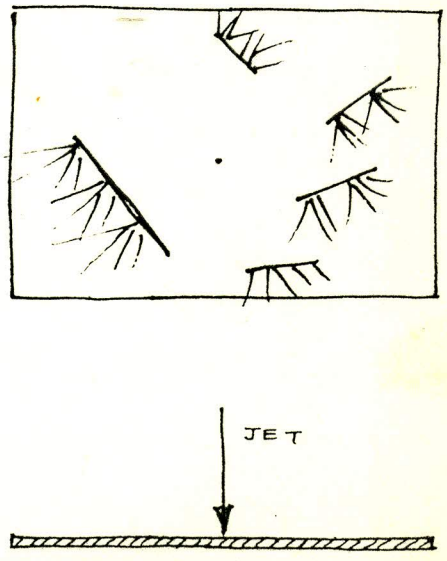
4.a.



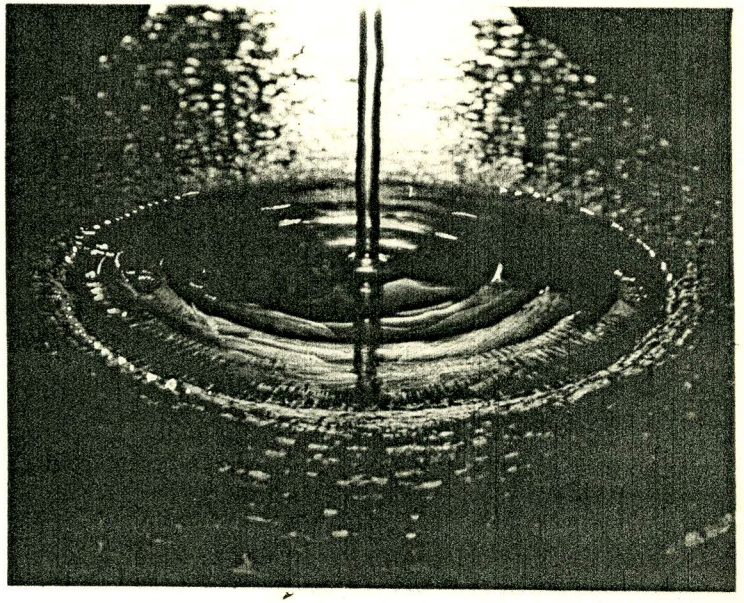
4.a.



4.b



4.C

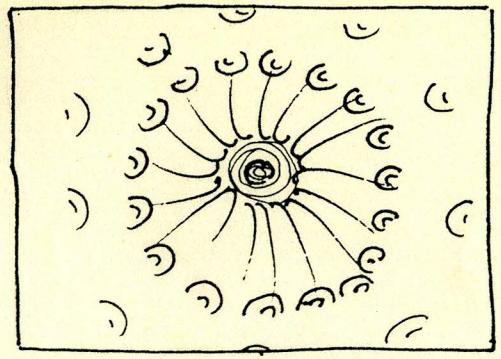


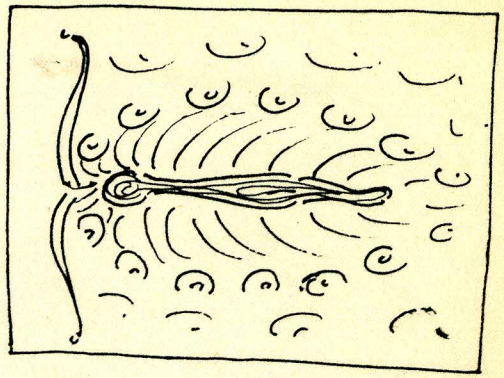
Ref. 4.a.

d. An acrylic sheet was kept horizontally and a jet was impinged on it vertically from the bottom, and the pattern was observed from top.

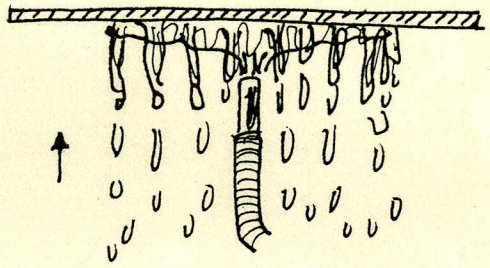
The jet forms a circular pattern consisting of radial lines terminating in large water drops on the circumference. The same pattern when seen from bottom, one can see the shower of water drops from the circumference.

e.f. By changing the angle of impingement a different kind of pattern can be created. Size of the pattern depends on the pressure of water and the distance of jet from surface.

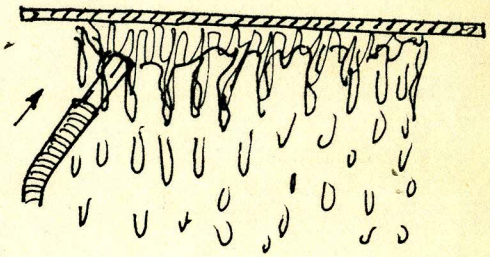




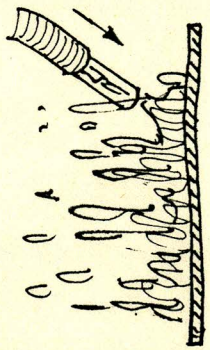
4.d.

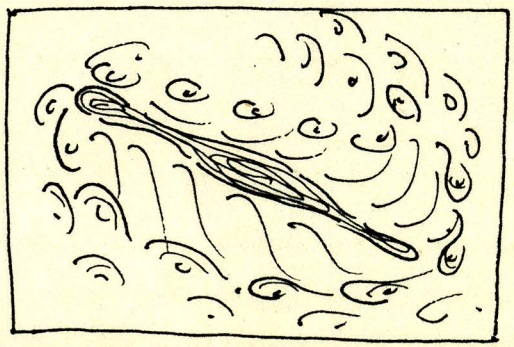


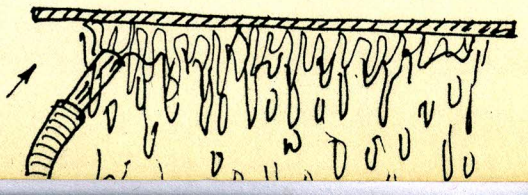
4.e.

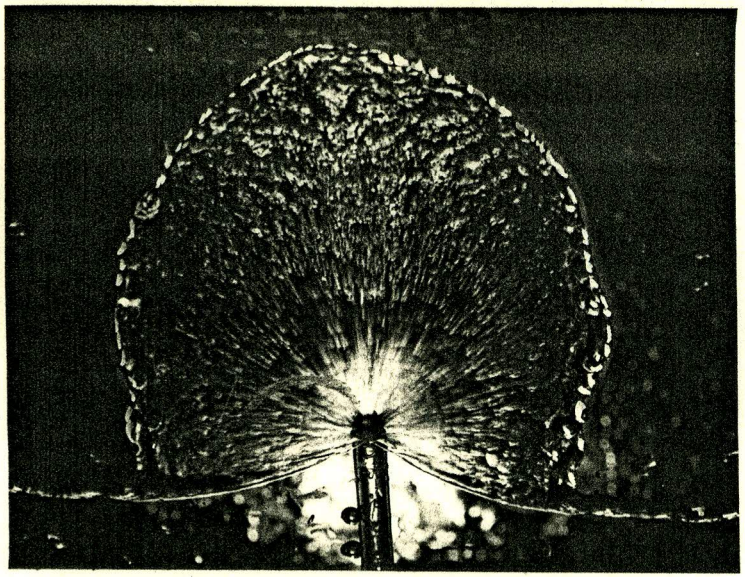


4.f.









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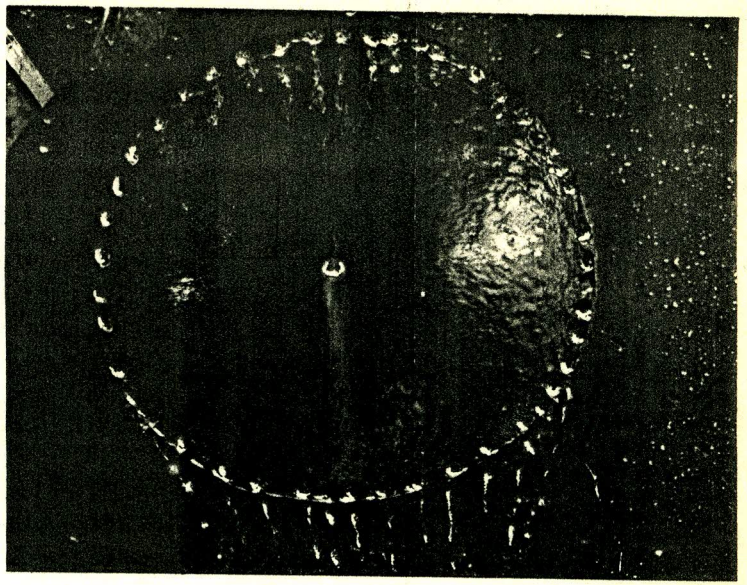
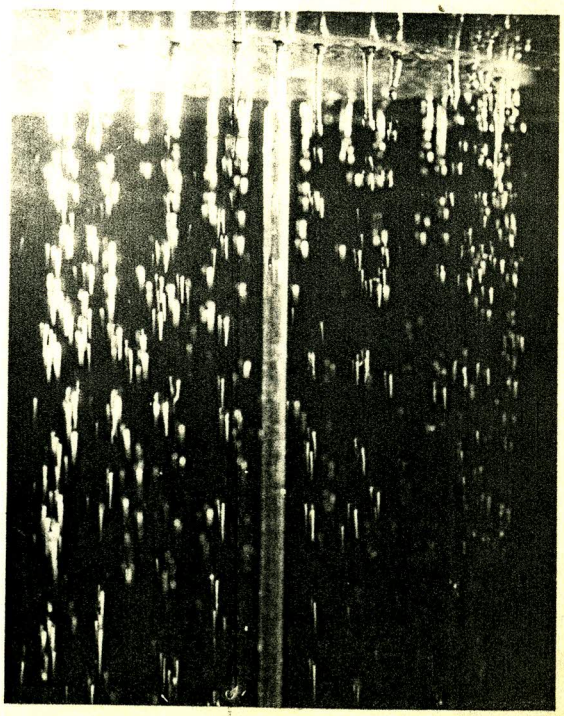


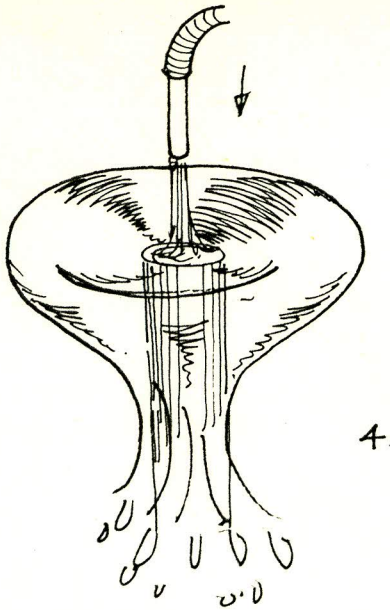
Ref. 4.d.

Ref. 4.d.

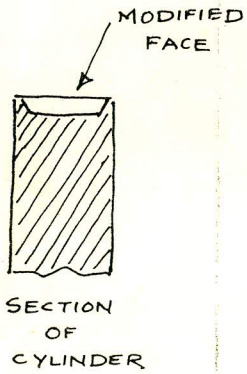


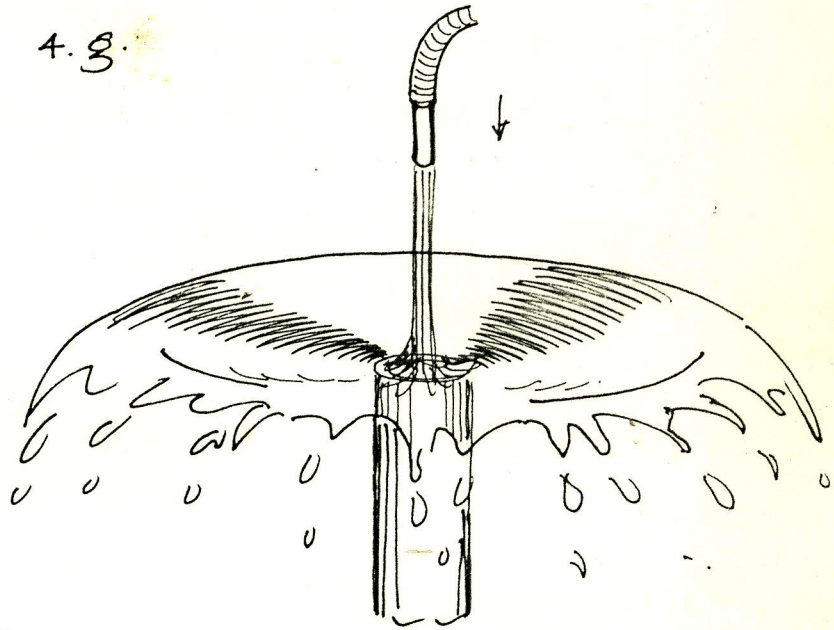
g. The jet was made to impige on the flat face of an acrylic cylinder, diameter of which was twice that of the jet. The flat face was slightly modified as shown.

By changing the distance between the flat face and the nozzle, various forms as shown in g,h,i were possible.

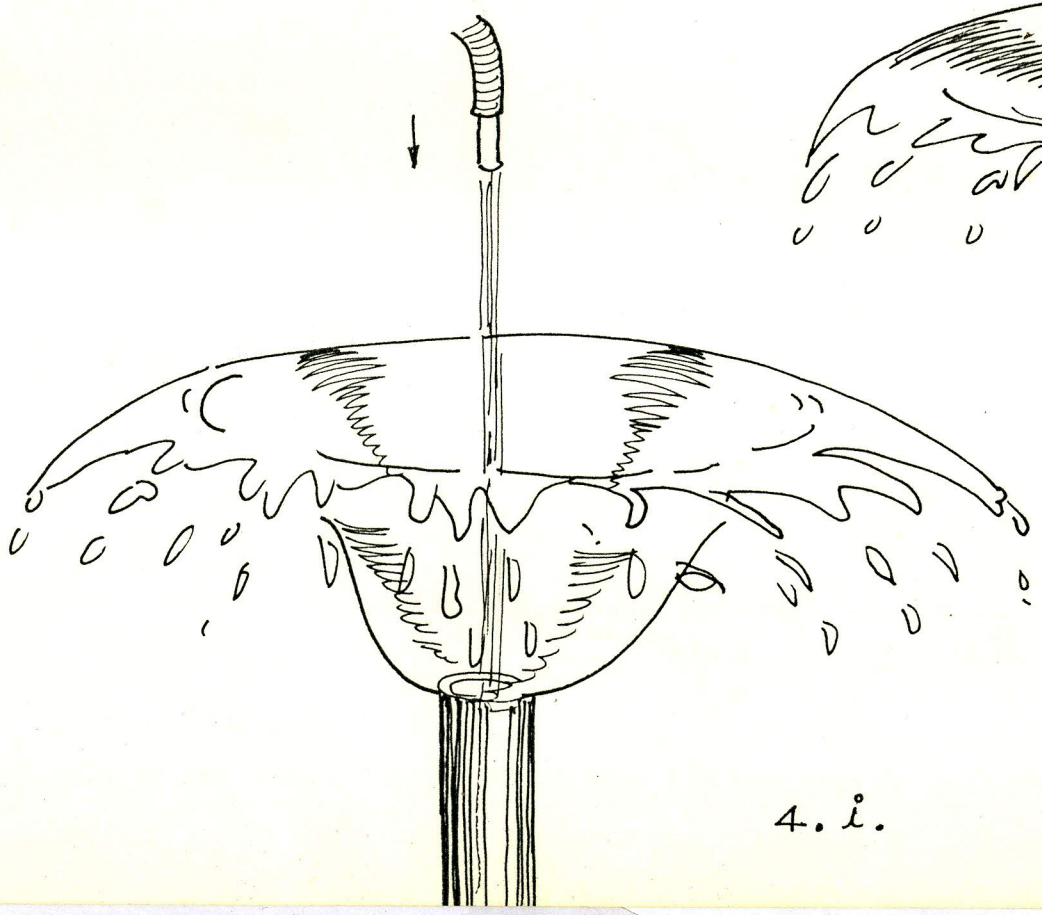


4.g.

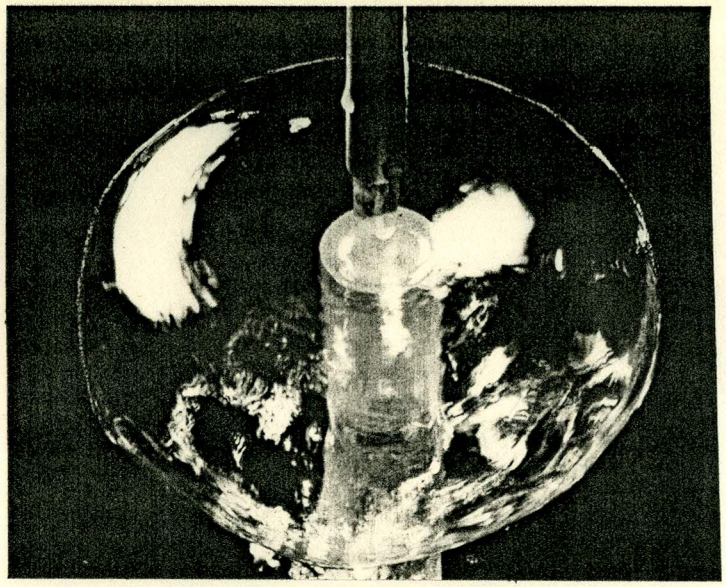




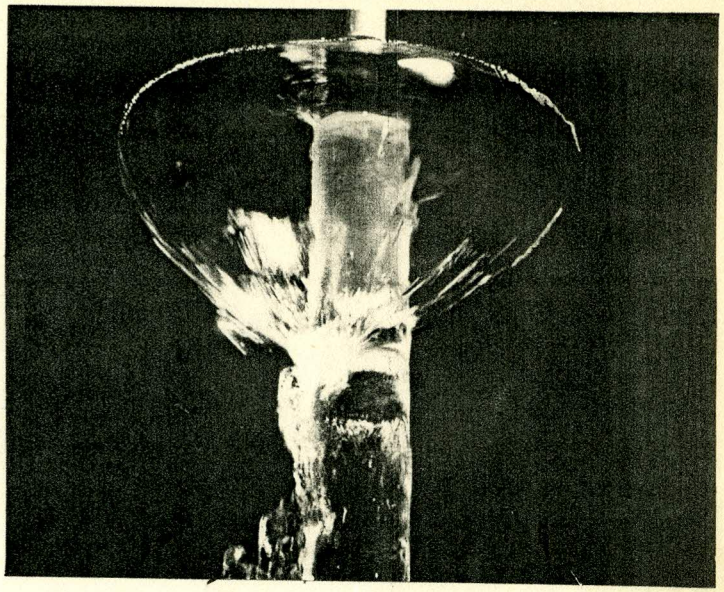
4.h.



4.i.

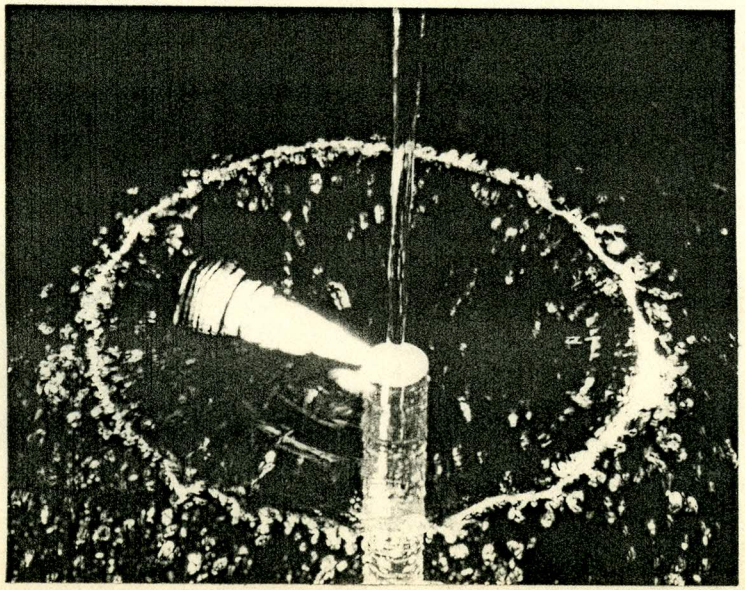


Ref. 4.g.

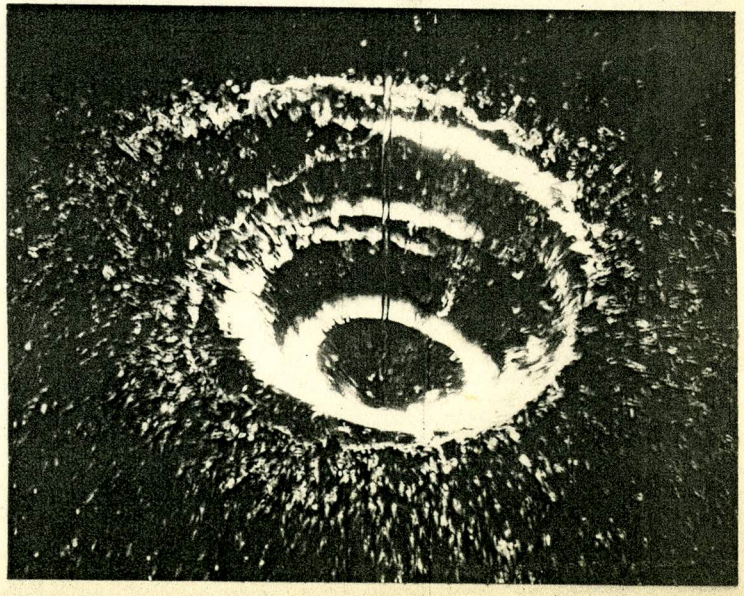


Ref. 4.g.

Ref. 4.h.



Ref. 4.i.



WATER AS A MEDIUM

The 'forms' shown in this study have neither scale nor meaning. What you see is the basic syntax by which one can build the language of water forms. To use water as a medium one might face difficulty initially as there are heavy constraints on it viz. Water has no color, it has no definite shape and it is heavily dependant on light to make it's presence felt.

The same goes for any media. If we consider the constraint not as a hinderance but as an advantage, only then can we exploit the full potential of that medium.

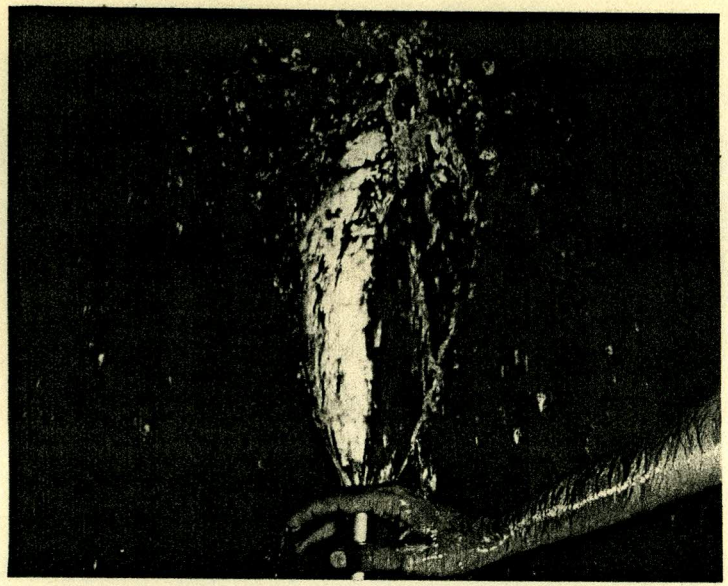
For example a 'chisel pen' used for calligraphy is an utterly useless instrument if one were to use it to write down notes. But once you recognise the constaint that it can draw only a particular type of line, it can work miracles in calligraphy.

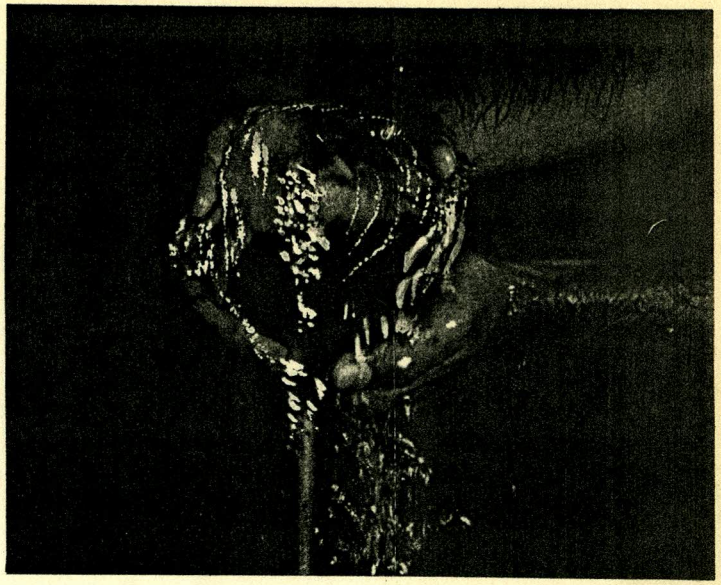
Another example is 'shadow play'

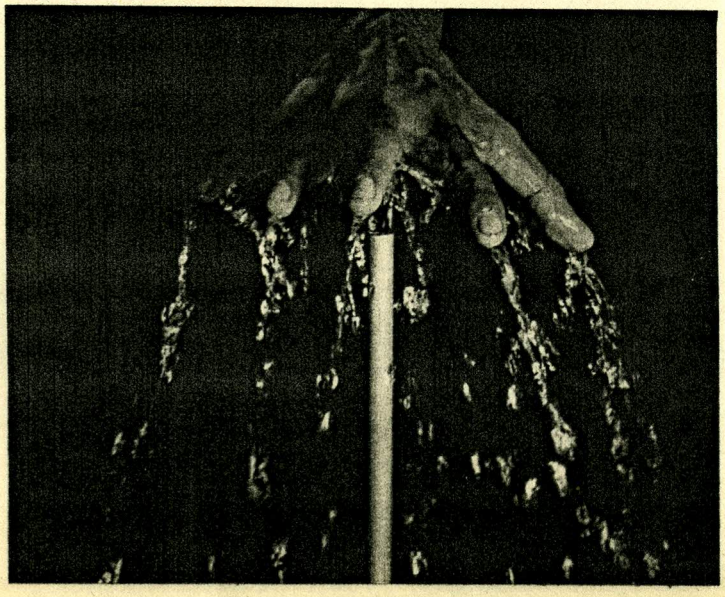
where just by using hands and a candle, one can obtain interesting shadows on the wall. Here the constraint is, light does not show the inner details as in photography but can only depict the contour. It is such constraints that make each medium unique. In fact more the number of constraints, greater is it's uniqueness.

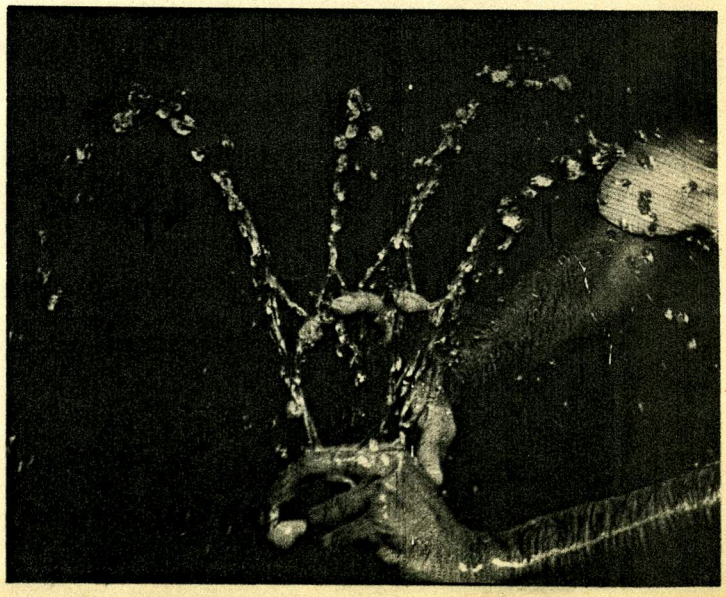
To explore water further, I tried something similar to shadow-play. I have just used one jet of water and my bare hands to explore the possibility of water forms. I have not explored this field in depth but is open for anyone to do so.

Some examples are shown on next page.



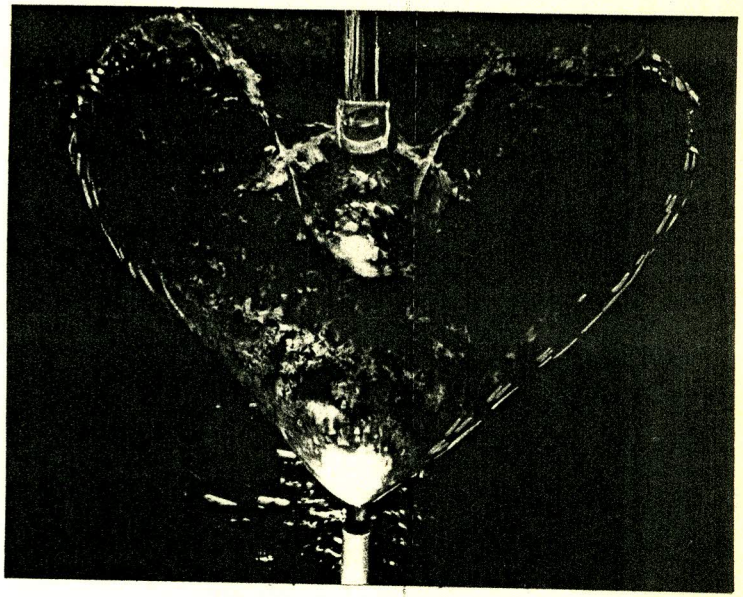


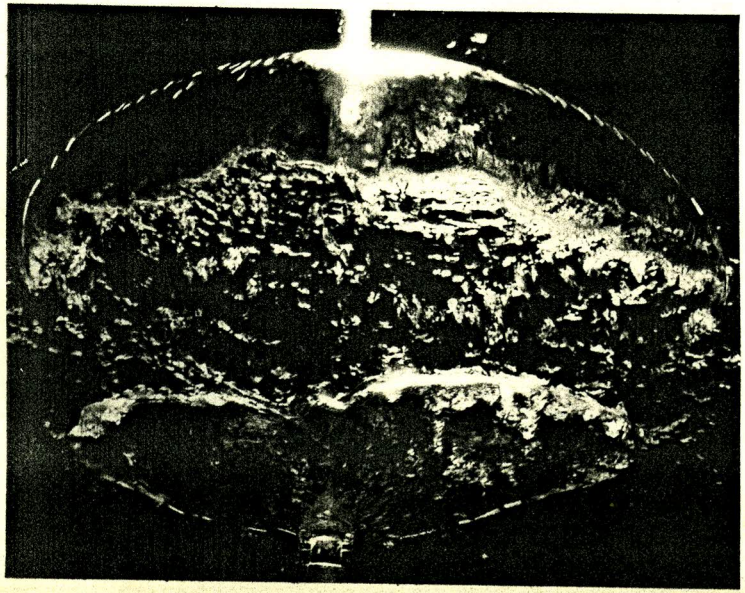


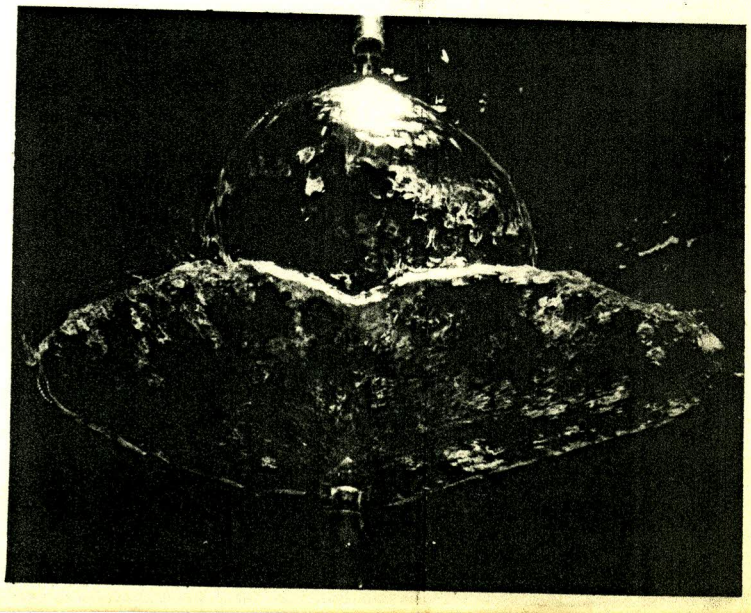


COMBINATIONS :

Combination of two or more 'forms' shown earlier can give interesting results like these. Large number of such forms are possible.







APPLICATIONS

1. The most obvious application that comes to mind is in fountains and gardens.

2. Many of the water forms shown are in the form of thin films and have very good cooling properties. These water forms can replace the cooling towers which we so sadly hide behind the buildings. If properly applied, these dumb and lifeless cooling towers can become lively sculptures worthy of being built right in front of the building.

3. Water form 1.e. and 1.f can be made big enough to become walk-in sculptures. These days lot of efforts are being made to design good and durable housing for the Antartic region. Now if in the Antartic region, we were to pump water to obtain a large water form of the type 1.e, it will freeze by the time water reaches ground. So we have instant

'igloos'. We can add many of these to get a whole structure. What's more, unlike all other structures, this will be fortified by the cold winds and snowfall as ~~the~~ time passes.

4. Another application is in 'Logos'. Big companies can have their company logo done in water.

These are but a few of the applications I could think of and it is always open for further investigation. Your imagination is the limit.

REFERENCE

	TITLE OF FILM	ACCESS NUMBER CENTRAL LIBRARY IIT-BOMBAY
1.	Waves in Fluids B/W	Pho 2843
2.	Turbulence B/W	Pho 2845
3.	Surface Tension in Fluid mechanics (colour)	Pho 2846
4.	Flow visualization B/W	Pho 2847
5.	Secondary flow (color)	Pho 2850
6.	Cavitation (color)	Pho 2853
7.	Flow instabilities (color)	Pho 2862