

## SOAP-BUBBLES,

AND THE FORCES WHICH MOULD THEM.

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(Continued.)

You see a photograph of a spider on her geometrical web (Fig. 38). If I had time I should like to tell you how the spider goes to work to make this beautiful structure, and a great deal about these wonderful creatures, but I must do no more



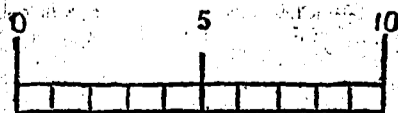
FIG. 38.

than show you that there are two kinds of web—those that point outwards, which are hard and smooth, and those that go round and round, which are very elastic, and which are covered with beads of a sticky liquid. Now there are in a good web over a quarter of a million of these beads which catch the flies for a spider's dinner. A spider makes a whole web in an hour, and generally has to make a new one every day. She would not be able to go round and stick all these in place, even if she knew how, because she would not have time. Instead of this she makes use of the way that a liquid cylinder breaks up into beads as follows. She spins a thread, and at the same time wets it with a sticky liquid, which of course is at first a cylinder.

This cannot remain a cylinder, but breaks up into beads, as the photograph taken with a microscope from a real web beautifully shows (Fig. 39). You see the alternate large and small drops, and sometimes you even see extra small drops between these again. In order that you may see exactly how large these beads really are, I have placed alongside a scale of thousandths of an inch, which was photographed at the same time. To prove to you that this is what happens, I shall now show you a web that I have made myself by stroking a quartz fibre with a straw dipped in castor-oil. The same alternate large and small beads are again visible just as perfect as they were in the spider's web. In fact it is impossible to distinguish between one of my beaded webs and a spider's by looking at them. And there is this additional similarity—my webs are just as good as a spider's for catching flies. You might say that a large cylinder of water in oil, or a microscopic cylinder on a thread, is not the same as an ordinary jet of water, and that you would like to see if it be-



FIG. 39.



Scale of thousandths of an inch

comes as I have described. The next photograph (Fig. 40), taken by the light of an instantaneous electric spark, and magnified three and a quarter times, shows a fine column of water falling from a jet. You will now see that it is at first a cylinder, that as it goes down necks and bulges begin to form, and at last beads separate, and you can see the little drops as well. The beads also vibrate, becoming alternately long and wide, and there can be no doubt that the sparkling portion of a jet, though it appears continuous, is really made up of beads which pass so rapidly before the eye that it is impossible to follow them. (I should explain that for a reason which will appear later, I made a loud note by whistling into a key at the time that this photograph was taken.)

Lord Rayleigh has shown that in a stream of water one twenty-fifth of an inch in diameter, necks impressed upon the stream, even though imperceptible, develop a thousandfold in depth every fortieth of a second, and thus it is not difficult to understand that in such a stream the water is already broken through before it has fallen many inches. He has also shown that free water drops vibrate at a rate which may be found as follows. A drop two inches in diameter makes one complete vibration in one second. If the diameter is reduced to one quarter of its amount, the time of vibration will be reduced to one-eighth, or if the diameter is reduced to one-hundredth, the time will be reduced to one-thousandth, and so on. The same relation between the diameter and the time of breaking up applies also to cylinders. We can at once see how fast a bead of water the size of one of those in the spider's web would vibrate if pulled out of shape, and let go suddenly.

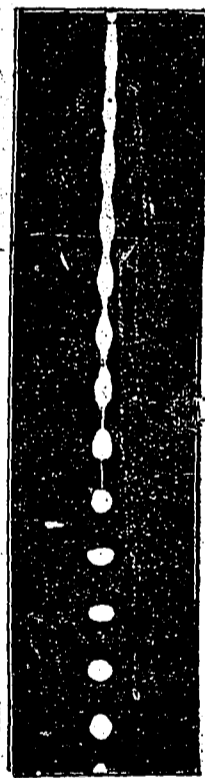


FIG. 40.

If we take the diameter as being one-eighth-hundredth of an inch, and it is really even finer, then the bead would have a diameter of one sixteen-hundredth of a two-inch bead, which makes one vibration in one second. It will therefore vibrate sixty-four thousand times as fast, or sixty-four thousand times a second. Water-drops the size of the little beads, with a diameter of rather less than one three-thousandth of an inch, would vibrate half a million times a second, under the sole influence of the feebly elastic skin of water! We thus see how powerful is the influence of the feebly elastic water-skin on drops of water that are sufficiently small.

I shall now cause a small fountain to play, and shall allow the water as it falls to patter upon a sheet of paper. You can see both the fountain itself and its shadow upon the screen. You will notice that the water comes out of the nozzle as a smooth cylinder, that it presently begins to glitter, and that the separate drops scatter over a great space (Fig. 41). Now why should the drops scatter? All the water comes out of the jet at the same rate and starts in the same direction, and yet after a short way the separate drops by no means follow the same drops. Now instead of explaining this, and then showing experiments to test the truth of the explanation, I shall reverse the usual order, and show one or two experiments first, which I think you will all agree are so like magic, so wonderful are they and yet so simple, that if they had been performed a few hundred years ago, the rash person who showed them might have run a serious risk of being burnt alive.

You now see the water of the jet scattering in all directions, and you hear it making a pattering sound on the paper on which it falls. I take out of my pocket a stick of sealing-wax and instantly all is

changed, even though I am some way off and can touch nothing. The water ceases to scatter; it travels in one continuous line (Fig. 42), and falls upon the paper making a loud rattling noise which must remind you of the rain of a thunder-storm. I come a little nearer to the fountain and the water scatters again, but this time in quite a different way. The falling drops are much larger than they were before. Directly I hide the sealing-wax the jet of water recovers its old appearance, and as soon as the sealing-wax is taken out it travels in a single line again.

Now instead of the sealing-wax I shall

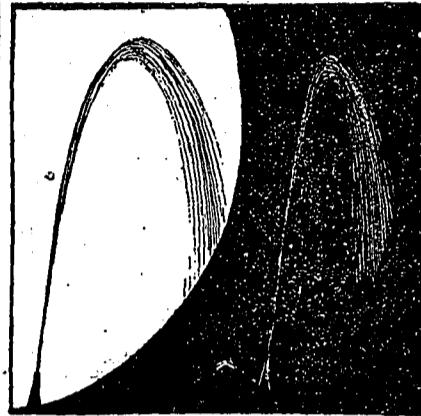


Fig. 41.

take a smoky flame easily made by dipping some cotton-wool on the end of a stick into benzine, and lighting it. As long as the flame is held away from the fountain it produces no effect, but the instant that I bring it near so that the water passes through the flame, the fountain ceases to scatter; it all runs in one line and falls in a dirty black stream upon the paper. Ever so little oil fed into the jet from a tube as fine as a hair does exactly the same thing.

I shall now set a tuning-fork sounding at the other side of the table. The fountain has not altered in appearance. I now touch the stand of the tuning-fork with a long stick which rests against the nozzle.

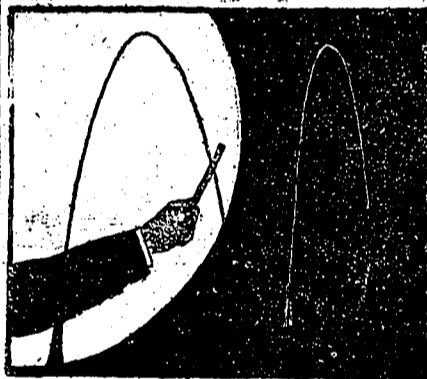


FIG. 42.

Again the water gathers itself together even more perfectly than before, and the paper upon which it falls is humming out a note which is the same as that produced by the tuning-fork. If I alter the rate at which the water flows you will see that the appearance is changed again, but it is never like a jet which is not acted upon by a musical sound. Sometimes the fountain breaks up into two or three and sometimes many more distinct lines, as though it came out of as many tubes of different sizes and pointing in slightly different

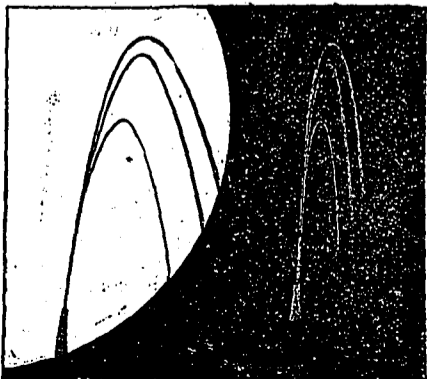


FIG. 43.

directions (Fig. 43). The effect of different notes could be very easily shown if any

one were to sing to the piece of wood by which the jet is held. I can make noises of different pitches, which for this purpose are perhaps better than musical notes, and you can see that with every new noise the fountain puts on a different appearance. You may well wonder how these trifling influences—sealing-wax, the smoky flame, or the more or less musical noise—should produce this mysterious result, but the explanation is not so difficult as you might expect.

I hope to make this clear when we meet again.

(To be Continued.)

## HOW BABY WENT HOME.

BY HELEN SOMERVILLE.

The door of Henning's saloon was pushed open by a little hand, and a child ran in, looking eagerly about. 'Papa, papa! Where's my papa?' she cried.

A man standing at the counter with a glass raised half way to his lips started at sound of the plaintive voice, and set down the untasted beer.

'What do you want, Bessie?' he asked.

'O papa, come home!' she exclaimed; 'baby's dying!'

'Baby's dying!' he repeated, mechanically, snatching up his hat, and taking the hand of the trembling child, they left the saloon together.

Down the street they went, the father and the child; he with bared head and lip trembling with emotion, she clinging to his hand, and sobbing out her grief in a helpless, hopeless manner.

They stopped at a tenement house and ascended the stairs, till they reached the fourth story, where they paused at room No. 86. On a wretched bed, covered by a ragged quilt, lay the tiny form of 'baby,' so still, so white, so pure, in the midst of the surrounding dirt and distress.

One glance, and a loud, agonized groan burst from the father's lips. 'My God! is our little darling to leave us?'

'O George!' sobbed his wife, creeping to his side, and laying her hand timidly on his shoulder. 'She called for "papa" right up to a few minutes ago. Our little baby will soon be with the angels.'

Reverently the husband and wife knelt beside the little form. The father took one tiny white hand in his large brown one. The mother took the other little hand, and covered it with tears and kisses.

'George,' sobbed the mother, 'God is going to take our darling. Don't you think that—to be—the parents—of a baby angel—that we ought—to be good.'

'Yes, Mary, I do, and from this time on, God helping me, I intend to be a different man.'

'Amen!' exclaimed Mary.

The baby stirred just then and smiled into the faces of her parents.

'All right, papa,' she murmured, then closed her eyes forever. Baby had fulfilled her mission.—*Ram's Horn.*

## HOW HE WAKENED GRAND-MOTHER.

Mamma said, 'Little one, go and see  
If grandmother's ready to come to tea'  
I knew I mustn't disturb her, so  
I stepped as gently along tip toe,  
And stood a moment to take a peep—  
And there was grandmother, fast asleep.

I knew it was time for her to wake;  
I thought I'd give her a little shake,  
Or tap at her door, or softly call:  
But I hadn't the heart for that at all—  
She looked so sweet and so quiet there  
Lying back in her high-arm-chair,  
With her dear white hair, and a little smile  
That means she's loving you all the while.

I didn't make a speck of noise;  
I knew she was dreaming of little boys  
And girls who lived with her long ago,  
And then went to heaven—she had told me so.  
I went up close and I didn't speak  
One word, but I gave her on her cheek  
The softest bit of a little kiss,  
Just in a whisper, and then said this:

'Grandma, dear, it's time for tea.'  
She opened her eyes, and looked at me,  
And said, 'Why, pet, I have just now dreamed  
Of a little angel who came and seemed  
To kiss me lovingly on my face—  
She pointed right on the very place.  
I never told her 'twas only me,  
I took her hand, and we went to tea.

—*Sidney Dawne.*