

SOAP-BUBBLES,

AND THE FORCES WHICH MOULD THEM.

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(Continued.)

I will give only one more example.

If you are painting in water-colors on greasy paper or certain shiny surfaces the paint will not lie smoothly on the paper, but runs together in the well-known way; a very little ox-gall, however, makes it lie perfectly, because ox-gall so reduces the strength of the skin of water that it will wet surfaces that pure water will not wet. This reduction of the surface tension you

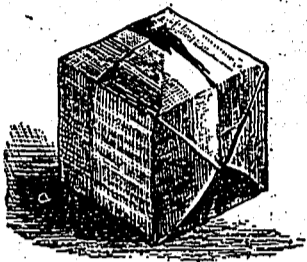


FIG. 15.

can see if I use the same wire frame a third time. The ether has now evaporated, and I can again make it rest against the surface of the water, but very soon after I touch the water with a brush containing ox-gall the frame jumps up as suddenly as before.

It is quite unnecessary that I should any further insist upon the fact that the outside of a liquid acts as if it were a perfectly elastic skin stretched with a certain definite force.

Suppose now that you take a small quantity of water, say as much as would go into a nut-shell, and suddenly let it go, what will happen? Of course it will fall down and be dashed against the ground. Or again, suppose you take the same quantity of water and lay it carefully upon a cake of paraffin wax dusted over with lycopodium which it does not wet, what will happen? Here again the weight of the drop—that which makes it fall if not held—will squeeze it against the paraffin and make it spread out into a flat cake. What would happen if the weight of the drop or the force pulling it downwards could be prevented from acting? In such a case the drop would only feel the effect of the elastic skin, which would try to pull it into such a form as to make the surface as small as possible. It would in fact rapidly become a perfectly round ball, because in no other way can so small a surface be obtained. If, instead of taking so much water, we were to take a drop about as large as a pin's head, then the weight which tends to squeeze it out or make it fall would be far less, while the skin would be just as strong, and would in reality have a greater moulding power, though why I cannot now explain. We should therefore expect that by taking a sufficiently small quantity of water the moulding power of the skin would ultimately be able almost entirely to counteract the weight of the drop, so that very small drops should appear like perfect little balls. If you have found any difficulty in following this argument, a very simple illustration will make it clear. You may

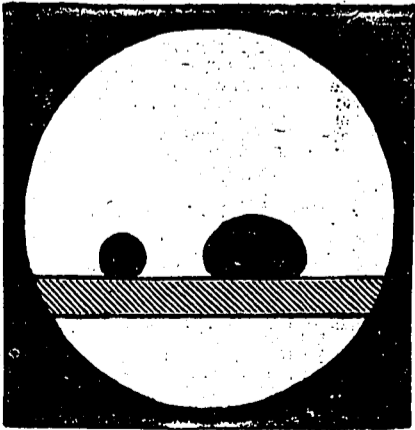


FIG. 16.

of you probably know how by folding paper to make this little thing which I hold in my hand (Fig 15). It is called a cat-box, because of its power of dispelling cats when it is filled with water and well thrown. This one, large enough to hold about half a pint, is made out of a small

piece of the *Times* newspaper. You may fill it with water and carry it about and throw it with your full power, and the strength of the paper skin is sufficient to hold it together until it hits anything, when of course it bursts and the water comes out. On the other hand, the large one made out of a whole sheet of the *Times* is barely able to withstand the weight of the water that it will hold. It is only just strong enough to allow of its being filled and carried, and then it may be dropped from a height, but you cannot throw it. In the same way the weaker skin of a liquid will not make a large quantity take the shape of a ball, but it will mould a minute drop so perfectly that you cannot tell by looking at it that it is not perfectly round every way. This is not easily seen with quicksilver. A large quantity rolls about like a flat cake, but the very small drops obtained by throwing some violently on the table and so breaking it up appear perfectly round. You can see the same difference in the beads of gold now upon the screen (Fig 16). They are now solid, but they were melted and then allowed to cool without being disturbed. Though the large bead is flattened by its weight the small one appears perfectly round. Finally, you may see the same thing with water if you dust a little lycopodium on the table. Then water falling will roll itself up into perfect little balls. You may even see the same thing on a dusty day if you water the road with a water-pot.

If it were not for the weight of liquids, that is the force with which they are pulled down towards the earth, large drops would be as perfectly round as small ones. This was first beautifully shown by Plateau, the blind experimentalist, who placed one liquid inside another which is equally heavy and with which it does not mix. Alcohol is lighter than oil, while water is heavier,

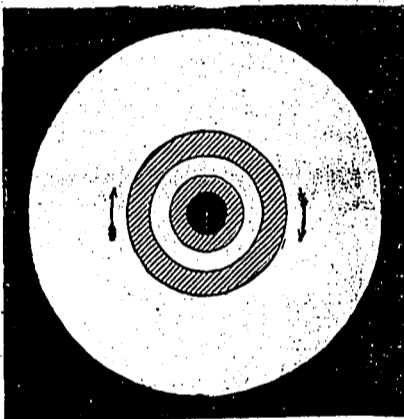


FIG. 17.

but a suitable mixture of alcohol and water is just as heavy as oil, and so oil does not either tend to rise or to fall when immersed in such a mixture. I have in front of the lantern a glass box containing alcohol and water, and by means of a tube I shall slowly allow oil to flow in. You see that as I remove the tube it becomes a perfect ball as large as a walnut. There are now two or three of these balls of oil all perfectly round. I want you to notice that when I hit them on one side the large balls recover their shape slowly, while the small ones become round again much more quickly. There is a very beautiful effect which can be produced with this apparatus, and though it is not necessary to refer to it, it is well worth while now that the apparatus is set up to show it to you. In the middle of the box there is an axle with a disc upon it to which I can make the oil adhere. Now if I slowly turn the wire and disc the oil will turn also. As I gradually increase the speed the oil tends to fly away in all directions, but the elastic skin retains it. The result is that the ball becomes flattened at its poles like the earth itself. On increasing the speed, the tendency of the oil to get away is at last too much for the elastic skin, and a ring breaks away (Fig 17), which almost immediately contracts again on to the rest of the ball as the speed falls. If I turn it sufficiently fast the ring breaks up into a series of balls which you now see. One cannot help being reminded of the heavenly bodies by this beautiful experiment of Plateau's, for you see a central body and a series of balls of different sizes all travelling round in the same direction (Fig 18); but the forces which are acting in the two cases are totally distinct, and

what you see has nothing whatever to do with the sun and the planets.

We have thus seen that a large ball of liquid can be moulded by the elasticity of its skin if the disturbing effect of its weight is neutralized, as in the last experiment. This disturbing effect is practically of no account in the case of a soap-bubble, because it is so thin that it hardly weighs anything. You all know, of course, that a soap-bubble is perfectly round, and now you know why; it is because the elastic film, trying to become as small as it can, must take the form which has the smallest surface for its content, and that form is the sphere. I want you to notice here, as with

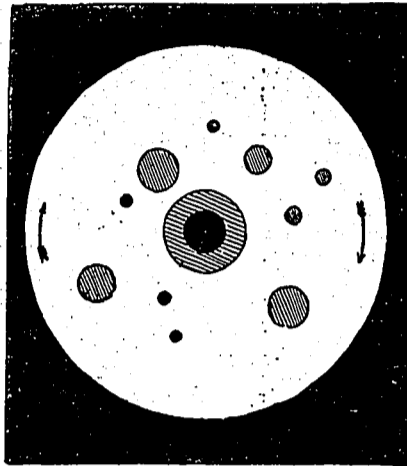


FIG. 18.

the oil, that a large bubble oscillates much more slowly than a small one when knocked out of shape with a bat covered with baize or wool.

The chief result that I have endeavored to make clear to-day is this: The outside of a liquid acts as if it were an elastic skin, which will, as far as it is able, so mould the liquid within it that it shall be as small as possible. Generally the weight of liquids, especially when there is a large quantity, is too much for the feebly elastic skin, and its power may not be noticed. The disturbing effect of weight is got rid of by immersing one liquid in another which is equally heavy with which it does not mix, and it is hardly noticed when very small drops are examined, or when a bubble is blown, for in these cases the weight is almost nothing, while the elastic power of the skin is just as great as ever.

(To be Continued.)

THE KING'S BOUNTY.

We had come in our Mission Home to a place of almost greater extremity than we had ever been allowed to reach before. Our money was entirely gone and the food in the house was all but exhausted, while our family was a large one and a hungry one. While we did not understand why our gracious Father should allow us to be thus in want and to stand so close to a still greater want, we remember that our faith was greatly strengthened, and that we were permitted to trust and to confidently rest in the perfect love that works no ill. Believing that the promises of God would be fulfilled, we made known our needs to no one outside of our Home, but individually and as a family continued to wait in prayer upon the living God. We had finished breakfast one morning, at which we had eaten almost the last article of food in the house, and had had our morning prayer service, when a lady friend, who had given her son to China, was shown into the parlor. I was surprised to see this visitor in the Home at that early hour of the day, knowing that she lived a long distance from us; and I was still more surprised when, having seated herself, she told me the following story in about these words: 'I have come this morning to give you ten dollars. Last night I was sitting up with a sick friend, and during the hours of the night had much opportunity for thought and prayer. While sitting alone, I began to wonder what I could do for the Mission, and the Lord seemed to remind me of ten dollars which I had, and to say to me, 'Go and give the China Inland Mission ten dollars.' I immediately remembered that I had laid the money aside for a cloak which I wished to buy, and I answered, 'But, Lord, I have put the money aside for a cloak, and I need it.' Again the Lord seemed to say

to me, 'Go, give the China Inland Mission ten dollars.' Again I answered, 'But, Lord, I need the cloak.' Still again the Lord seemed to answer, 'Go, give the China Inland Mission ten dollars.' There was a real and prolonged struggle, but at last I replied, 'Yes, I will do so.' I went home from my friend's house, got the ten dollars, and have come directly here.' I must confess I was almost startled at such a revelation of the Lord's direct dealing with one of His children. I could not doubt the story, however, as the friend who was before me was a most devout and sober-minded child of God.

However, I was not quite sure that the gift of the money was really an answer to our prayers and a provision for our need, as the lady, in offering the amount, had not designated it for us. In order to make certain of this, I asked, 'And how would you like the money used?' The friend replied, 'For your home expenses.' If I was startled before, I was much more so now, for it was plain enough that the Lord had indeed spoken to His child and had sent her to us in answer to our prayer in this remarkable manner. But still I hesitated; remembering about the cloak, I had no heart to take the money offered, and asked our friend if she would not reconsider the matter, reminding her at the same time, that the money had been first of all designated for the purchase of that garment, and that she undoubtedly needed it. 'Oh, no,' she said, 'I will have no peace until I give the money to you.' I could hesitate no longer, and accepted with grateful thanks that which the Lord had so evidently sent. This gift, made under such peculiar circumstances, gave us the assurance, as few other answers to prayer have done, that we were indeed being accepted in Christ in the service which we were offering to Him. I may add also, that the dear friend who was thus used of God to minister to us, felt that she had obtained, through her gift, one of the largest blessings of her life; for though she had lost the cloak which she had intended buying, she felt that she had obtained from the Lord's own hand that 'garment of praise' which gives the true-hearted followers of Christ such joy to wear.—*China's Millions.*

OF THE LIQUOR TRADE.

It creates no wealth, it earns nothing, it lives upon the earnings of other trades; it adds nothing whatever to the wealth or power of the State, nor to the prosperity or comfort of the people. This trade is wasteful like war; it destroys more of the wages of the people and the results of useful industries than 'war, pestilence and famine combined'; it creates more than three-fourths of the poverty, pauperism and crime of the country, and more than one-half of the insanity; it inflicts a premature and shameful death upon more than sixty thousand people annually; it transforms hundreds of thousands of good industrious citizens into drunkards, vagabonds and tramps, it sends an infinite misery into hundreds of thousands of homes; it puts the people down and keeps them down; its effect is to make the people ignorant, coarse, vulgar, brutal, enemies to law, order and good government. Such are part of the certain effects of this trade. There is not now and never has been in this country a locality where the policy of license has diminished the liquor traffic or the evils coming from it. No one has ever suggested that under license the demand for liquor would not be fully met and freely supplied. The friends of temperance in Maine will never consent to establish by law and give legal protection to a trade which inflicts far more evil upon the community than comes from all other causes of evil combined.—*Neal Dow.*

WINDOW FACES.

Windows look when opened wide
Laughing fit to split their side.

When they're only opened half
They seem to have a jolly laugh.

When they're raised a peg or two
They smile as bashful children do.

When they're shut and will not budge
They're quite as sober as a judge.

Look up and down the street, and see
If they laugh at you as they do at me.

—*Youth's Companion.*