HOW TO CARRY WATER IN A SIEVE.

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We are accustomed to conceive of liquids as possessing perfect or almost perfect mobility, and as being destitute of cohesion. Within themselves they do possess mobility in a high degree; the molecules are attracted by the molecular forces equally in all directions, so that cohesion is not discernible. But if a very thin layer of liquid is separated from the mass, or even has one side or face exposed, its molecules are no longer attracted equally in all directions, and the force of cohesion appears. An old experiment illustrating this may be cited here. A wine glass with dry edges is filled with water. By proper precautions a number of coins may be dropped into it, the water rising up above the glass to an eighth of an inch or more. (See SUPPLEMENT, No. 232.) In this case the surface film of the

Fig. 1.—EMPTYING CYLINDER.

water by its cohesion and tension holds the water together as would an elastic rubber membrane.

The same phenomenon appears in a pendent drop of water, when we conceive of it as being a mass of fluid contained in a sack or purse of water film. Shot is made by pouring melted lead through a perforated vessel and letting the shower of drops fall through the air until chilled. In this case each drop is drawn into a spherical shape by the tension of the film of liquid lead surrounding it. If a tube of small caliber is immersed for part of its length in water, the fluid will rise within it. Adhesion between the liquid and the glass draws up the edges or periphery of the liquid column only, while the tension and cohesion of the surface film pull up the column, the tendency being to flatten the meniscus or curved upper surface. In this way the fluid rises up some distance in the tube. In the mathematical consideration of the problem, three tensions are generally assumed—water-air, water-glass, and air-glass; but the expression involving the condition of adhesion is preferable where mathematics are not to be used.

Thus, the action of sponges, lamp wicks, and the swelling of dry wood when moistened are due to films almost infinitesimal in area and quite so in thickness, that move through the pores of the solid bodies and draw threads of water after them. Capillary action cannot take place without the existence of a film.

In general terms, the strength and tension of a film are supposed to be due to the molecular attraction of its ultimate particles. These are not attracted equally in all directions for want of an inclosing liquid, so that the attractions which do exist strain the mass together.

Finally, the persistence of so fragile a thing as a film

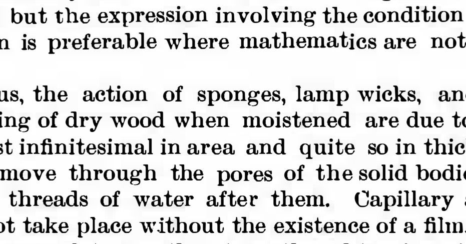


Fig. 2.—EMPTY CYLINDER.

or membrane of water is most striking when its dimensions are reduced. This naturally increases its apparent strength, and makes it have proportionately a more secure hold upon any bounding surface that it adheres to.*

In the cuts, a cylinder adapted to illustrate most strikingly some of the phenomena of capillarity or film action is shown. It is constructed of No. 100 brass wire gauze. Its ends are closed with solid plates or with pieces of the same gauze. Assuming it to be made, the following experiments may be tried with it.

It is immersed in a basin of water, and allowed to remain under the surface until thoroughly wet. This may take several hours with large cylinders; small ones one inch to one and a half in diameter are very quickly moistened. Repeated immersions of short duration sometimes are quite effective. It is now lifted out in a horizontal position. If perfectly wet, it will be completely filled with water. The old problem of the Danaides is solved—a perforated vessel is filled with water; we are carrying water in a sieve. Next the cylinder should be held between the eyes and the light, when its beautiful silky or icy luster will be seen.

The water is retained because the meshes are filled with water film. To empty it, we need only remove some films from their respective meshes. This is most simply done by blowing against the upper surface, Fig. 1, when, as the air is admitted, the water streams out, and in an instant the cylinder is empty. Where the film was blown away, a characteristic spot can be seen, Fig. 2. Now, it can be again immersed, keeping the open meshes uppermost, and it will fill with water. If the meshes had not been blown open, no water would have entered except under considerable pressure. If, after blowing upon the meshes, and while the water is running out, we close the meshes again, it will cease to escape. This can easily be done by shaking the cylinder, so as to dash the water upward and refill the meshes. The outflow immediately stops, and we have a partially filled cylinder, Fig. 3. The question may be asked, Why does not the film at the bottom of the cylinder hold in the water after the upper meshes are blown upon? The reason is simple. As air is admitted above it, the body of the fluid, yielding to gravity, descends and carries the film with it, new water filling the openings in the gauze, until all escapes except what is left to fill the meshes. This action cannot take place at the upper surface, because no water is supplied to keep the meshes full.

If, however, we do this, and pour water on the upper surface when the cylinder is quite or partially full, the water will go through the upper meshes into the cylinder, and escape from the bottom, Fig 4; as soon as we cease pouring, the outflow ceases. In entering, the water is assisted by the suction the column of contained fluid produces. If the cylinder is perfectly empty and perfectly wet, water cannot be poured through it. The lower meshes will not relinquish their films, whose weight is too slight to overcome their adherence to the wire.

These cylinders are most conveniently made on a mould. A wooden cylinder is a good object. The edges of the longitudinal seam are bent over and caught in each other, the mould inserted, and the seam rubbed down with a piece of wood or the back of a penknife. Then the seam is soldered. The ends of the open cylinder are next to be "tinned." This stiffens them, so that they may be bent into true circles. The end pieces, cut out a little larger in diameter, are to be "tinned" around the edges, and then soldered in their places. Solid ends of brass or lead may be used with advantage. Some little trouble may be experienced, as the solder spreads with great facility through the texture by this same capillarity, but a little care will keep the area of the seams within limits. The diameter may be as much as three inches, but the smaller ones are the easiest to use and most certain to work well. It would be advantageous to use rings of sheet brass on the ends to come between the ends and bottoms, but they are not needed, as solder alone will answer.

* For exhaustive series of experiments on films and surface tension, see SUPPLEMENT, Nos. 160 and 495.

Mechanical Properties of Cork.

Mr. William Anderson lately delivered a lecture at the Royal Institution "On New Applications of the Mechanical Properties of Cork to the Arts." The lecturer began by demonstrating experimentally that in solid substances no appreciable change of volume resulted from change of pressure; even India rubber was shown to be extremely rigid. Cork, however, appeared to be a solitary exception to this law, being eminently capable of cubical compression, both from forces applied in opposite directions and from pressure from all sides, such as arose when the substance was immersed in water and subjected to hydraulic pressure. The cause of this anomalous and valuable property of cork was then investigated, and it was shown to arise from its peculiar structure, which rendered it, in many respects, more like a gas than a solid. Cork was composed exclusively of minute closed cells, the walls of which were readily permeated by gases, but were impervious to liquids. The cells were filled with air, which, when pressure was applied, yielded readily, and expanded again when the pressure was removed.

The impermeability of the cells to liquids prevented cork from getting water-logged when exposed to such fluids in bottles and in the new applications devised by the lecturer; and this property, combined with permeability to gases, rendered cork superior to India rubber in waterproof clothing, because it permitted transpiration while excluding the wet. Mr. Anderson next proceeded to explain some of the practical applications which he had made.

The first was the substitution of cork for air in the air vessels of water-raising machinery. This was illustrated by a hydraulic ram, which worked a fountain about 10 feet high in the lecture room. Another application was the storage of a portion of the energy of the recoil of guns, and employing it for the purpose of running them out when ready for firing. The gun carriage was very much like that commonly in use, with hydraulic compressors, but the water in the cylinders was driven by the recoil into a vessel filled with cork, which was thus compressed. The cylinder was separated from the cork vessel by an automatic valve which prevented the reflux of the water. As soon as the gun was loaded, a tap was opened; the cork was then free to expand and liberate the water back into the cylinder, so running out the gun. The lecturer pointed out that

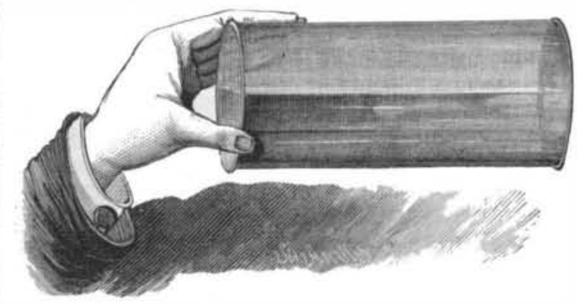


Fig. 3.—CYLINDER PARTIALLY FILLED.

this method of using cork would allow of a gun being run out up any incline. The system was peculiarly adapted for naval use, where inclined planes became inoperative in the event of the vessel having a list in the opposite direction. The lecture, which was profusely illustrated by means of diagrams and experiments, certainly placed cork in a new light before the scientific world, and indicated fresh and extensive fields for its use.

Progress of Marine Engineering.

The steamer Aller, 5,500 tons, 455 feet long by 48 feet broad, was tried on the Clyde recently, and exhibited remarkable results in the matter of economy in coal consumption. The Aller is a distinct advance in speed and economy on account of her triple-expansion engines and boilers. To develop 6,000 indicated horse power in the compound engines, by the same builders, requires a consumption of 130 tons per 24 hours. In these triple-expansion engines the consumption is 90 tons.

A still more remarkable comparison is shown by the results of ocean voyages by experimental engines, from the designs of which those of the Aller have been constructed. It will be remembered that part of the price paid by the Cunard Company for the Umbria and the Etruria was made up of the two steamers Parthia and Batavia, which are now the property of Mr. Pearce, M.P., President of the Fairfield Company. The old compound engines were removed by him to

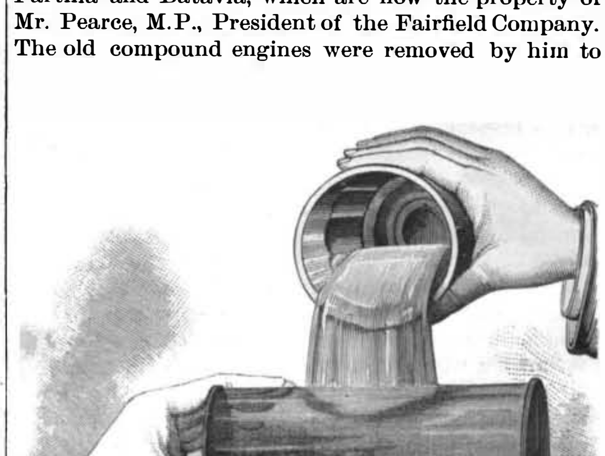


Fig. 4.—POURING WATER THROUGH FULL CYLINDER.

make room for triple-expansion engines and steel boilers. The log of the Parthia in 1883 shows that she burnt 47 tons of coal per day of 24 hours when going at a speed of 11 knots. Her log during 1885-86 shows that the consumption was 25 tons at the same speed. Her speed is now much higher, but the comparison must be made with her old rate. The Batavia shows still better results. The consumption in 1883 was 40 tons per day at 11 knots. In 1885, with the new engines, it was only 21 tons.—*London Times.*

Ghosts and Haunted Houses.

In spite of the rigid suppression of everything regarded as superstitious which characterizes the present times, there are a number of traditions and half beliefs which still retain a wonderful vitality. The existence of those apparitions which are popularly supposed to choose the weird hour of midnight for their perambulations, and of those inexplicable manifestations which gain for a dwelling the unenviable name of being haunted, has been affirmed by persons of such undoubted veracity, and believed in by so many of unquestioned intelligence, that a movement has recently started in different parts of the country for the thorough investigation of the reputed phenomena, with a view of deciding whether they have any substantial foundation, or must be accredited to individual mental vagaries.

It must, however, be remembered that it is no argument in favor of their genuineness that these traditions are so universal, for Grimm and other students of comparative philology have shown that many of our best known nursery tales have elements in common with the folk lore of but distantly related people, and with these must be attributed to the ancestral store before the Aryan dispersion. It is unnecessary to say that we do not on this account believe in the existence and sad fortunes of an original Red Riding Hood, or in the exploits of an actual Jack the Giant-killer. And neither can we claim any additional respect for ghosts and similar apparitions because the earliest Aryan mother sent her child to sleep with stories of monsters or fairies, according as the infant had been naughty or good, while later mothers have drawn upon the traditional "man in the dark" to induce obedience. But the present investigators who are taking up this subject have manifested a neutrality which promises most interesting results, should any be reached. They are neither prejudiced by the antiquity of these supernatural entities, nor so far incredulous as to dismiss the whole matter with a contemptuous denial. Viewed thus dispassionately, ghosts and haunted houses form an excellent subject for scientific investigation. At the present time, two cities in particular are holding these popular but still fascinating terrors up to the light of day, and we dare say that in a number of other localities similar societies are investigating their claims to recognition with equal rigor.

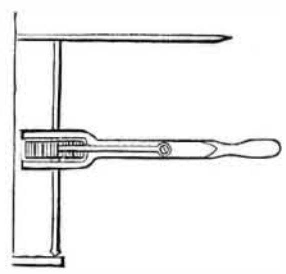
In Boston, the American Society for Psychical Research has appointed a special committee on apparitions and haunted houses. A circular has been issued, inviting communications from those whose experience may enable them to be of assistance in the examination. They desire information, in the first place, regarding reported cases of apparitions of the absent or dead. From time to time, such accounts have been published, giving all the details of the occurrence, and a great deal that would be of immense interest could it be verified. These supernatural appearances are often reported as foretelling future events, usually of a disastrous nature, such as illness or death, and the committee is particularly anxious to acquire all possible testimony in regard to cases where such premonitions have been intelligently recorded and have afterward proved true in whole or part. In addition to these more dramatic spectacles, there is a large class of personal experiences, such as presentiments in connection with material appearances, and the like, which would be of undoubted interest in such an investigation. The testimony of persons who have had these experiences themselves, or have had an opportunity to record the experience of others, is of special value. In making such records, it is important to state the age, occupation, temperament, condition of health, and other personal factors which would be apt to influence the result of such an experience, together with the appearance, circumstances of time and place, duration, etc., of the supposed apparition. It is also of great importance, where any warning is thought to have been conveyed, to know whether it was recorded before verification, in order to give as little play to the imagination as possible. The committee, as we have stated, undertake this investigation without preconceived prejudices. Being very bright people, they cannot help having their own opinions, and it would be safe to say that the majority are without belief in such appearances; but they wish simply to hear and examine the facts, and are pledged to draw from them such conclusions as are warranted by the evidence. They invite the co-operation of persons similarly earnest and unprejudiced. Col. T. W. Higginson, Cambridge, Mass., is one of the committee. A limited time will also be devoted to the personal examination of houses in the neighborhood of Boston which are reported to be haunted.

In Philadelphia, an analogous though less open investigation is now in progress. Some years ago, Mr. Seybert, the donor of the new bell for Independence Hall, was the victim of severe imposition at the hands of several over-thrifty "mediums." At his death he left a sum of money to the University of Pennsylvania on the condition that it should thoroughly investigate the claims of spiritualism, and make the results public. The committee intrusted with the task has been collecting testimony on this point for a number of months, but no results, we believe, have yet been published. It is to be hoped that their labor will shortly be completed and their conclusions made public.

WHO INVENTED THE RATCHET BRACE?

This question is asked in a recent number of the *Engineer*, London, by a correspondent who writes to the editor as follows:

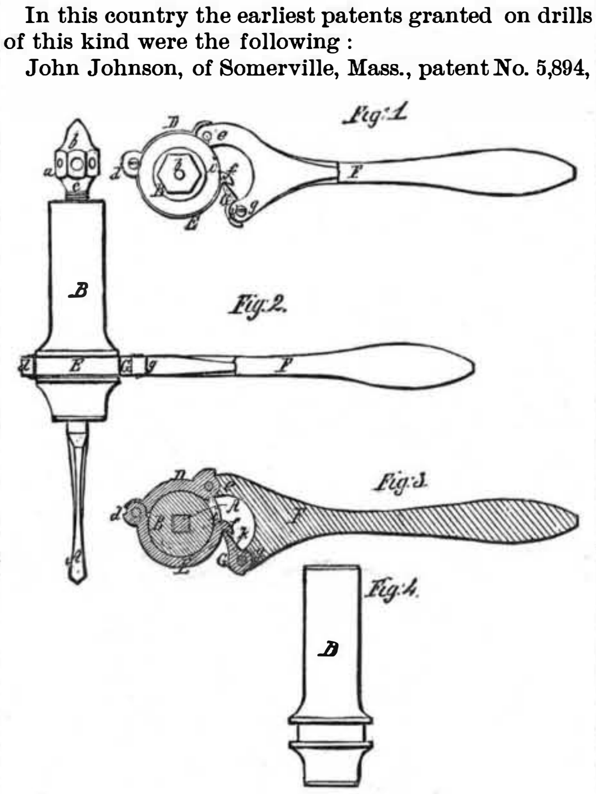
"In the *Mechanics' Magazine* for September 5, 1835, there is a sketch of "a simple drill," said to be the invention of a workman in Mr. Hague's manufactory. Hague was a well known engineer half a century ago, his shops being somewhere near the Tower, I think. I send a reduction of the sketch, and should like to know whether this is the first ratchet brace.



The date of the introduction of that useful tool may be within the recollection of some of your older readers, and it may also be possible to preserve the name of the inventor. ENQUIRER.

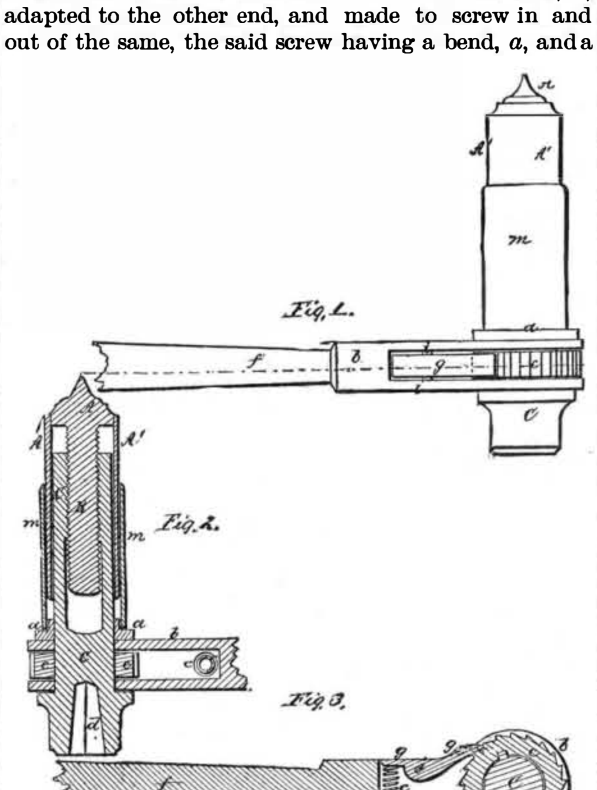
In this country the earliest patents granted on drills of this kind were the following:

John Johnson, of Somerville, Mass., patent No. 5,894,



JOHNSON'S DRILL, 1848.

dated October 31, 1848.—A exhibits the drill and B the stock or drill holder. The latter is made with a socket in one end to receive the drill. It has also a screw, C, adapted to the other end, and made to screw in and out of the same, the said screw having a bend, *a*, and a



PACKER'S DRILL, 1858.

conical projection, *b*, on the upper end of it; the said projection serving for a center to steady the drill. The stock, B, is made with a suitable groove turned around in it to receive two friction bands, D E, which are jointed together, as seen at *d*. The band, D, is jointed to a projecting arm, *e*, of a forked lever, F, while the band, E, has a hooked end against which a small toggle rests and bears. The said toggle is jointed to another or short arm, *g*, of the lever, F, the whole being arranged as shown. The joint of the toggle is so made as to prevent any outward movement of the toggle (that is to say, a movement of it toward the stock) beyond about a right angle to the arm to which it is attached. The said movement, however, when the toggle is borne against the hook, *f*, must be sufficient to allow the two friction bands, D E, to move freely around upon the stock without any bind or friction, such as will cause it to rotate forward with the lever, F, when said lever is moved in a direction away from the person who grasps it. The joint of the toggle should also be constructed in such manner as to allow the toggle to move toward the inner end of the lever. Now, if the drill be placed in position, a movement of the lever toward the operator causes the toggle to so act against the hook of the friction band, E, as to draw or force the two bands, D E, toward one another, and causes them to firmly grasp the drill stock with a degree of friction sufficient to rotate it and the drill with the further movement of the lever. The retraction or reverse movement of the lever will cause the friction bands to unloosen their hold upon the stock, so as to permit the lever to be moved forward to the extent required without creating any corresponding rotation of the drill stock.

Henry H. Packer, of Boston, Mass., patent No. 20,728, dated June 29, 1858.—C is the screw barrel, the upper end of which is bored out and tapered to accommodate the screw, B, the lower end being so constructed as to have formed therein a socket for the reception of a drill. The head of the screw, B, is conical at top, as seen at A, forming a pivot, and has projecting from its perimeter downward a shell, A', which (when the screw, B, is at its lowest point in the barrel, C) entirely surrounds said barrel its whole length. C' is a ratchet wheel, which is keyed on to the lower end of the barrel or drill stock, *c*, and rotates in an eye or slot formed in the spindle stock, *b*, for its reception; said ratchet is caused to revolve, carrying with it the band, C, screw, B, and shell, A', and any tool which may be secured in the shank at *d*. At every half stroke or every other vibration of the spindle stock, *b*, by means of the pawl, *g*, working in a pivot, *i*, and kept in gear with said wheel (at the proper times) by a spiral spring, *e*. The frame or stock, *b*; is furnished with a suitable handle, *f*, on the top of the stock, *b*; and surrounding the barrel, A, is a collar, *a*, from which extends upward a shell, *m*, surrounding the shell, A', the greater part of its length.

The operation is nearly similar to those already in use, and requires but little explanation. The whole mechanism is caused to partially rotate at every forward shake or vibration of the handle, F, by means as already described, while at every backward stroke the pawl, *g*, rides over the ratchet wheel, C, leaving the mechanism stationary. When it is desired to feed the drill, the screw, B, is turned by a simple key or lever fitting a hole in its head.

The Great Question of the Day.

The late Dr. Samuel D. Gross, the father of American surgery, used the following words in an address delivered at the dedication of the McDowell monument:

"Young men of America, listen to the voice of one who has grown old in his profession, and who will probably never address you again, as he utters a parting word of advice.

"The great question of the day is not this operation or that, not ovariotomy or lithotomy, or a hip joint amputation, which have reflected so much glory upon American medicine, but preventive medicine, the hygiene of our persons, our dwellings, our streets, in a word, our surroundings, whatever or wherever they may be, whether in city, town, hamlet, or country, and the establishment of efficient town and State boards of health, through whose agency we shall be more able to prevent the origin and fatal effects of what are known as the zymotic or preventable diseases which carry so much woe and sorrow into our families, and often sweep like hurricanes over the earth, destroying millions of human lives in an incredibly short time.

"The day has arrived when the people must be roused to a deeper and more earnest sense of the people's welfare, and suitable measures adopted for the protection as well as for the better development of their physical, moral, and intellectual powers. This is the great problem of the day, the question which you, as the representatives of the rising generation of physicians, should urge, in season and out of season, upon the attention of your fellow citizens; the question which, above and beyond all others, should engage your most serious thoughts, and elicit your most earnest co-operation.

"When this great object shall be attained; when man shall be able to prevent disease, and to reach, with little or no suffering, his threescore years and ten, so graphically described by the Psalmist, then, and not until then, will the world be a paradise."