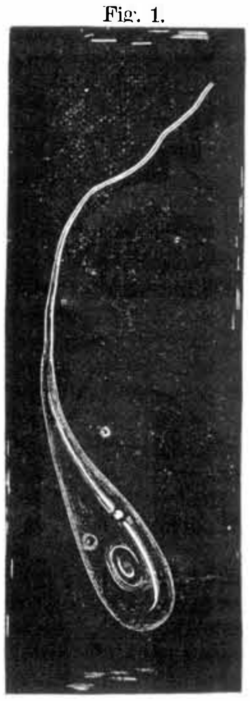
TEMPERED GLASS.

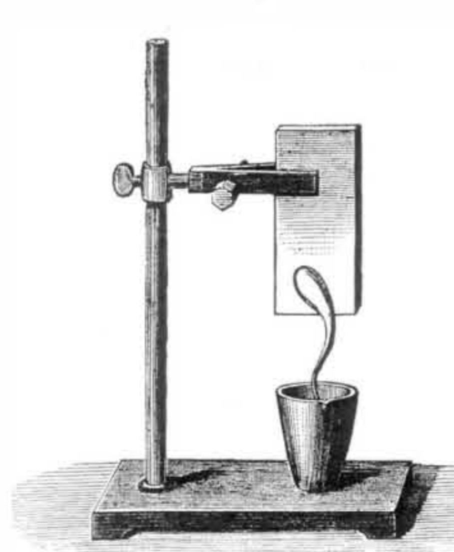
[Our readers are familiar with the practice of hardening steel to a degree in excess of the requirements, and then reducing it the exact degree of softness which will give the required flexibility and toughness. The latter process is called tempering; and the absence of brittleness and the durability of the steel when in use is properly called its temper. In the following article, however (which we translate from *La Nature*) the noun temper is used as the equivalent of the French noun *trempe*, which properly signifies the hardening and not the reducing process; but it adequately gives the meaning of the word, if this explanation be borne in mind.—Eds.]

Fig. 1.



A substance is said to be tempered when, after having been heated, it is suddenly cooled. Ordinarily this result is obtained by plunging it while hot into a cold liquid; and the degree of temper is proportionate to the heat of the object and also to the rapidity and extent of the cooling. The effects thus produced may be partially or wholly removed by annealing. This operation, the inverse of tempering, consists in reheating the tempered material and then cooling it slowly. If it is reheated to the temperature to which it had previously been raised, no trace of temper remains; if it is brought to a lower temperature during a shorter time, the effects of tempering are only lessened. The remarkable properties possessed by tempered steel are well known; but generally, it is not so well understood that other bodies, such as phosphorus, sulphur, certain alloys, etc., experience on being tempered interesting modifications, some of which have been utilized in the arts.

Fig. 2.



The tempering of glass and the curious properties thus acquired by that substance was first studied during the seventeenth century, when "Batavian tears," or "Prince Rupert's drops" were first produced. These objects are now frequently made in glass works, as curiosities, and are retained by allowing melted glass to drop or extend slowly from the end of a rod into a vessel of cold water. The piece

Fig. 3.

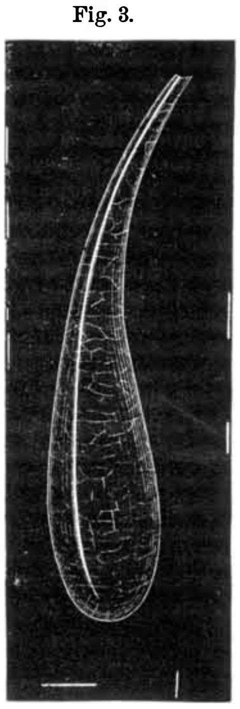
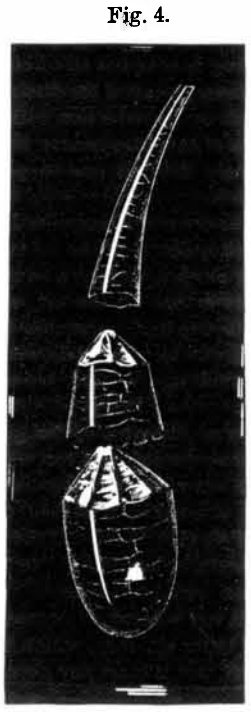


Fig. 4.



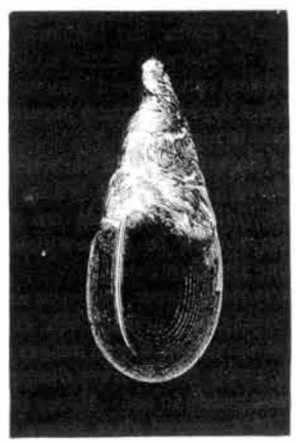
which assumes a tear or drop shape, as shown in Fig. 1, is, on cooling, broken from the rod. The curious feature about these tears is that, while they will resist the blow of a hammer on their thick portion, the breaking off of a small piece of the tail causes them at once to fly into a myriad of fragments. It has hitherto been supposed, in order to account for the above, that the exterior of the glass cooled first, and solidified, while the material within, cooling more slowly,

Fig. 5.

Fig. 6.

was prevented by its rigid envelope from contracting, and hence remained in a state of fixed dilatation. Consequently, according to this theory, on breaking the outer envelope, the

Fig. 7.



unstable equilibrium of the interior molecules would result in their disaggregation.

The investigations of M. Victor de Luynes, however, tend

Fig. 8.

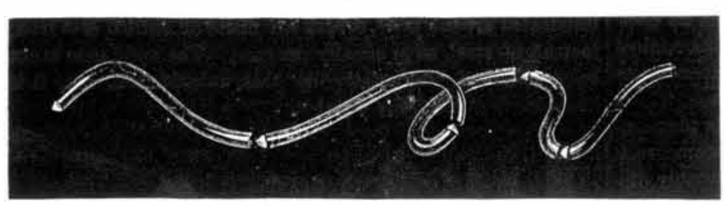


Fig. 9.

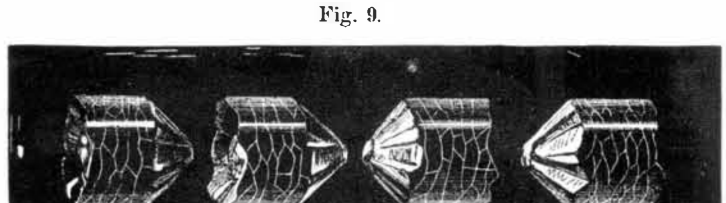
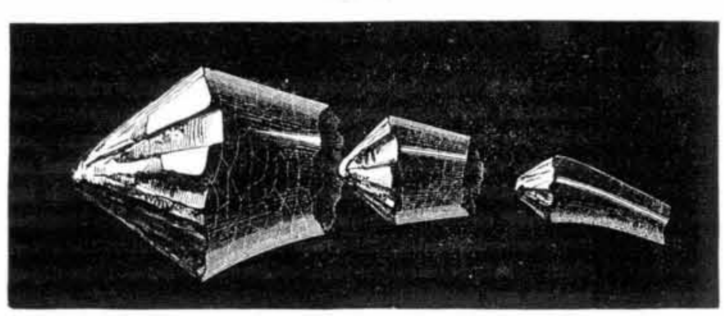


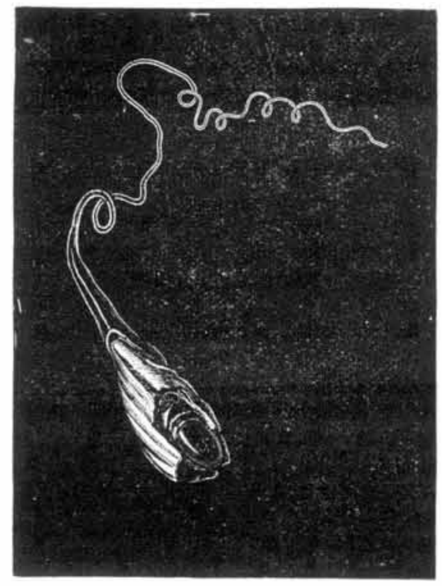
Fig. 10.



to show that the effects noted are due principally to a particular state of the exterior layers of the tears, and that the interior of the mass plays only a secondary part in the phenomenon. The experimental proofs are as follows: A tear is so suspended above a platinum vase of hydrofluoric acid that only the extremity of the tail enters the liquid. As the latter eats away the glass, the drop is lowered, and in this way it is found that it is possible entirely to dissolve away the tail without determining an explosion; but when the neck (that is to say, the point of divergence of the pear-like form) of the tear is reached, equilibrium is always disturbed. Reciprocally, on introducing the large end into the acid, the layers of glass are successively eaten away, and the tear becomes completely dissolved, leaving only the tail and the point of origin, or neck, as before.

These two experiments prove, first, that the stability of the tear depends especially on the existence of the parts of the glass which constitute the origin of the neck, and that, as regards these parts, so long as they are kept intact, all the exterior layers of the tear may be removed without determining explosion. Hence it follows that the said layers are not necessary to the maintenence of equilibrium. By gradually destroying the enlarged portion by hydrofluoric acid the tear is reduced to a nucleus. If several rather large tears be thus treated, and if the action of the acid be arrested at different periods for each, nuclei of different sizes are obtained, of which the explosive properties vary

Fig. 11.



in intensity. When the tear is thick enough an inert nucleus is reached, which breaks under a shock like ordinary glass.

The tear made in the manner above described may be considered as formed by the superposition of unequally tempered and hence unequally dilated layers of glass. This dilatation of the exterior layers by the temper produces a bending or flexure analogous to that obtained by compressing the tear in the direction of its axis so as to expand it transversely. Supposing a section to be made in the tear in a plane passing through the axis, the glass in the exterior layers, which M. de Luynes terms the active ones, would be in the same state as in a plate of glass submitted to flexure; the exterior parts being dilated, the interior parts compressed, and the two being separated by a neutral stratum where the glass remains in its natural state. In the tear, the flexion would be carried to its maximum, or, in other words, the conditions would be the same as if the plate of glass were bent so that its extremities touched. All the layers extended or compressed by flexion unite at the neck of the tear; and for this reason it will be seen that, upon the unimpaired existence of the neck depends the stability of the tear; and also that, on destroying the said neck, the active layers, by virtue of the elasticity developed by the flexure are free to exercise their spring-like action to regain equilibrium, and in so doing to destroy the whole tear. If, on the contrary, the exterior layers are slowly dissolved, the neck being preserved, the layers which remain are maintained by the resistance of the interior layers, and equilibrium is not upset.

If the unequal flexions, due to the inequal-

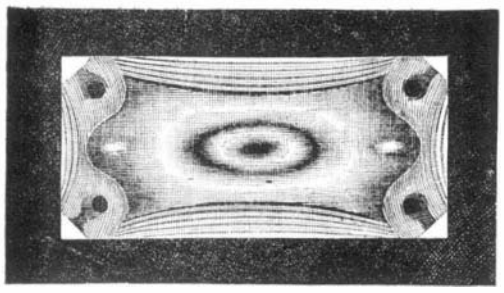
Fig. 12.

ity of temper of the exterior layers, determine rupture by their elasticity when permitted to detach themselves the molecules of glass of each layer should be displaced in inverse direction, according as the rupture takes place from the tail or from the large end; and hence there should result a difference in the arrangement of said molecules after the rupture. The central portions of a transverse section which belong to slightly tempered layers should not become displaced, while, with the molecules of the outer highly tempered strata, the reverse should be true. Hence after rupture, a trundcate cone should be produced, the summit of which should be directed either to the tail or to the large end, according as the tempered layers had been set at liberty from one or the other other extremity.

In order to verify this, a tear was half inclosed in plaster, as in Fig. 2. The tail was attacked with hydrofluoric acid, and the large end was cut with a saw. After rupture, the fragments were held in place by the plaster, and their position and form could thus be conveniently studied. The tear usually remains as in Fig. 3, and on separating the fragments it is found to be composed of numerous truncated cones mutually imbedded. Fig. 4 shows a tear, the tail of which has been destroyed by acid. The summits of the cones are turned in the direction of the tail. In Fig. 5 the tear has been cut at the large end, and the summits are turned in the opposite direction to that noted in the preceding case. Finally, in Fig. 6 is shown a tear sawn through the middle, in which the summits are directed in opposite directions on each side of the point of division.

There are various other facts which tend to confirm the mode of structure already attributed to the Batavian tears

Fig. 13.

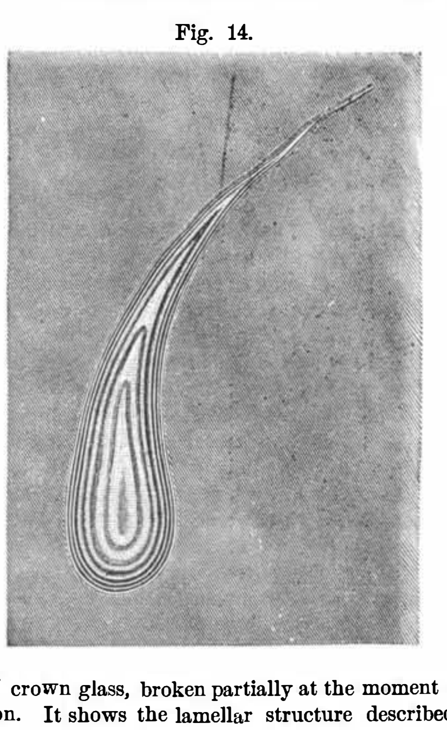


Thus, when the tear is partially attacked by the acid, the tail sometimes disaggregates simultaneously with the layers near the surface. A tear is then obtained having the form shown in Fig. 7. This is due to the manner in which the drop is produced, the tail being the prolongation of the exterior layers. In this way also perfectly inert nuclei may be obtained.

Cylindrical rods of tempered glass present phenomena similar to those shown by the tears. On heating a rod at one end it often breaks along its entire length, exhibiting a conical needle-like fracture. If more or less thick threads of molten glass be dropped in water, after the manner described for making tears, they solidify in spirals sometimes very long, sometimes greatly twisted. These threads possess very high tension, due to the temper of the superficial strata, so that, by attacking the spirals or twisted tubes with acid at one portion of their thickness, they explode like Batavian tears. On imbedding the tubes in plaster and cutting them in the middle, to the right and left of the cut will be observed the conical disposition of scales, placed in contrary directions, as shown in Figs. 8 and 9.

When the tempered threads are very fine, they are then very strongly twisted; and it suffices to plunge one extremity in hydrochloric acid to determine immediate explosion. When masses of glass are drawn out to produce cylindrical rods, there remain at the extremities pear-shaped pieces, resembling large tears and weighing perhaps 2 lbs. each. When separated from the blowpipe these fragments break on cooling, like tears cut at the large end, and present the conical fracture with the summits directed to the large extremity, as shown in Fig. 10. A piece of one of these huge tears, which had accidentally become broken, showed a curious phenomenon. On being pressed between the fingers, it became suddenly heated to about 80° Fah., the heat being probably disengaged at the moment of rupture. In Fig. 11 is represented

Fig. 14.



a tear of crown glass, broken partially at the moment of solidification. It shows the lamellar structure described very clearly.

The properties of tempered glass may be noted in any glass object which, after being highly heated, is rapidly cooled in the air. The "philosophic phial," which glass blowers often make at the extremity of their blowpipes, in order to test the quality of the glass, is an instance in point. After examination, the object, Fig. 12, is carelessly thrown on the ground, and left to cool. It will bear quite a strong blow delivered on its outside, but the dropping of any hard body into it causes it to burst into countless pieces.

The properties hitherto noted in Batavian tears, may be found in tempered glass, and they are present in degree proportional to the temper. If, however, the glass is but partially tempered, it is no longer possible to determine the degree thereof by rupture. Recourse must then be had to another characteristic presented by all tempered glass, without regard to the intensity of temper; namely, the action of the glass upon polarized light. The tempering process, by producing in the glass changes of elasticity in various directions, causes phenomena of double refraction which may be determined by the coloration manifested with polarized light. If a rectangular plate of glass, tempered by cooling in the air, is placed between two nicol prisms (turned to extinction), there are obtained, by causing the parallel rays to traverse the glass, very brilliant colorations, disposed as represented in Fig. 13. The form of these colored figures depends on that of the plate.

When objects in tempered glass are not cut with parallel faces, the direct observation of the figures under polarized light becomes more difficult. The following elegant method of observation has, however, been proposed by M. Mascart. As ordinary glass and liquid carbolic acid have very nearly the same degrees of refrangibility and dispersion, a glass rod plunged in the acid becomes almost invisible. M. Mascart puts the masses of tempered glass which he desires to observe into glass vessels with parallel sides, filled with carbolic acid. The conditions are then the same as if the vessel and its contents were one solid block of glass with parallel sides, and the observation may be made exactly as if such were the case.

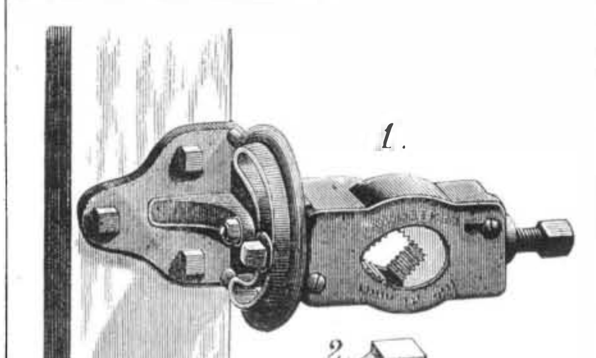
We may now subject the Batavian tear to the test of polarized light; but in order to interpret the indications which we shall obtain, another experiment will be necessary. A flat, rule-shaped piece of glass is inserted in a vise. When placed between two nicol prisms, it produces no phenomenon. Now the screw is turned down, and the glass is bent. As the flexion proceeds under the influence of the polarized light, a black band is first seen in the middle of the rule; then the edges become colored, and then numerous colored bands appear. Relax the screw; these phenomena disappear, and the normal state is regained.

We next place a Batavian tear in carbolic acid in a vessel having parallel faces. When the whole is subjected to polarized light, Fig. 14, colored bands are seen around the contour of the tear, similar to those which we previously obtained by bending the glass rule.

Thus optics prove that temper produces analogous effects to those due to mechanical action, such as flexions; with this difference, that the effects due to temper are permanent, while those which result from flexion disappear as soon as the producing cause ceases to act. Hence the study of the optical properties of tempered glass shows that it is in the same state as glass submitted to bending; and thus we reach a similar conclusion to that already based on the fracture of the glass.

THE CENTENNIAL PIPE VISE.

The principal novel features in the new pipe vise herewith illustrated are the jaws, which are made of chilled cast iron, instead of steel, as is usually the case. The appliance is not only rendered less costly by this substitution, but, it is claimed, is much more durable.



The jaws, 2, having corrugated or fluted surfaces which come in contact with the pipe or other object held, are placed loose in the box or jaw holder, 1; and a cover which swings as upon a hinge, keeps them in position. The bench plate and the box are connected by means of two bolts, one of which is a center or swivel bolt, and the other, at a suitable distance from the said center, traverses the circular slot in the bench plate. This, when tightened, secures the vise and the object held at any desired angle.

Among the other advantages claimed is the trifling expense of repair, the cost of a new set of jaws being less than one third that of repairing steel ones. By simply opening the box cover, one or both of the jaws may be removed and new ones substituted. This is the work of a moment, and the vise is rendered as good as new. The simplicity of construction is obvious from the illustration.

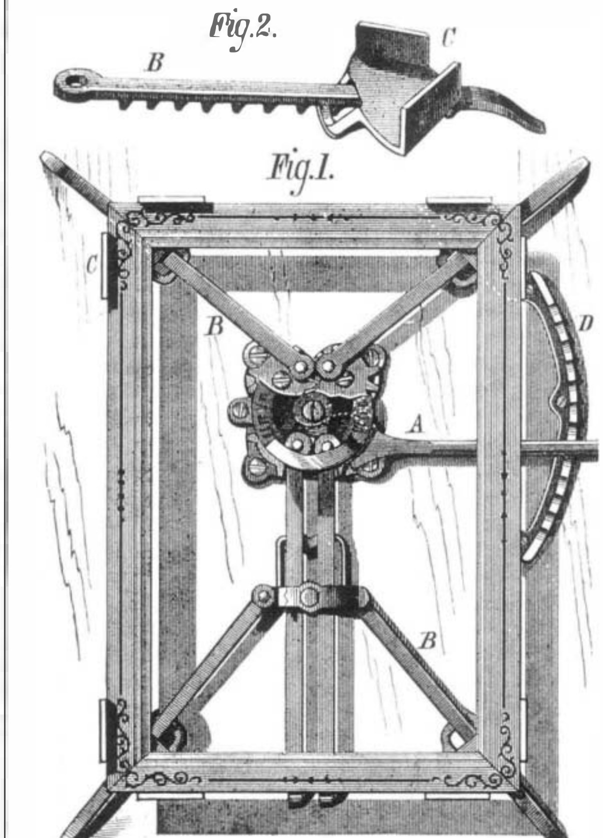
For further particulars address the Exeter Machine Works, William Burlingame, agent, Exeter, N. H., or 140 Congress street, Boston, Mass.

A NEW water and grease proof paper is obtained by saturating paper with a liquid prepared by dissolving shellac at a moderate heat in a saturated solution of borax.

WIETING'S IMPROVED FRAME CLAMP.

We illustrate herewith a new and convenient device for clamping picture and looking-glass frames, sashes, boxes, and other work secured together at the corners by glue or nails, etc. It may also be used for holding pieces of joinery of different shape during the setting of the glue or cement.

To the bench or bedpiece is attached a metal plate, on which four lugs are cast. One lug serves as a bearing for a toothed segmental lever, A, and the others form pivots for cog-wheels, which intermesh with the segment on the lever and with each other, so as to form a connected train of gearing. On the upper sides of each of the wheels and the lever are pins, which serve as pivots for the clamping rods or stretchers, B, Fig. 2. Lastly, over the wheel a cap (broken away in Fig. 1) is secured.



The stretchers, B, are formed with lugs on their under faces, and their outer ends are bent down so as to keep the rods horizontal. On these stretchers are placed shoes, C, which are readily adjustable thereupon by the engagement of the loops on said shoes with the lugs on the stretchers. These shoes are formed with ears at right angles to each other, with an intermediate space so as to allow the ends of the corners of the frame to project beyond them. The ears are covered with leather, felt, or paper, to prevent marring the frame.

To operate the machinery, it is simply necessary to adjust the shoes, C, on the stretchers in accordance with the size of the frame, each shoe being set in relatively the same position, so as to secure a perfect square or rectangular frame. The pieces composing the frame, having glue put on their ends, are laid in their relative positions; the lever is slightly drawn, when the corners can be properly adjusted, and the lever drawn as tight as may be, and locked by the rack, D, when the frame may be nailed without danger of displacement.

Patented May 16, 1876. Machines or territory can be had by applying to A. Wieting, Fort Plain, N. Y.

To Distinguish Bitter Almond Oil from Nitro-Benzol.

When benzol from coal tar is treated with strong nitric acid, it is converted into, nitro-benzol, a substance closely resembling in odor the oil of bitter almonds. Several methods have been proposed for distinguishing the two, one of which depends on its reduction with nascent hydrogen. The result in case of the nitro-benzol is aniline, but the test is an exceedingly difficult one to perform, except by experienced chemists.

An easier one is suggested in Wittner's *Seifenfabrikation*. A small quantity of the oil is dissolved in 8 or 10 parts of strong alcohol, adding a solution of caustic potassa equal in volume to that of the oil used, and then evaporating the mass to one half. Genuine bitter almond oil, when treated thus, forms a clear yellowish liquid, while nitro benzol is converted into a hard brown mass, over which is a clear liquid.

If an adulteration of the genuine oil with some artificial kind is suspected, this test will not suffice; but the adulteration is detected by determining the boiling point. Oil of bitter almond boils at 180° C. (356° Fah.,) and nitro-benzol at 213° C. (415° Fah.). If the oil to be tested boils at a higher temperature than 180° C., or 356° Fah., it indicates an adulteration with nitro-benzol.

This test will not of course, distinguish the new artificial oil of bitter almonds, which has the same composition as the natural, nor is there any necessity for distinguishing it.

DYEING BLUE GREY ON GAUZE.—For 22 lbs. stuff, take through a water containing 17 ozs. sulphuric acid, and rinse well; and then, at 176° Fah., through a fresh beck of 3½ ozs. nigrosin and 2 lbs. 3 ozs. alum, and dry.