Correspondence.

A Remarkable Rainbow.

To the Editor of the SCIENTIFIC AMERICAN:

I desire to call your attention to a most remarkable rainbow that I, with several others, witnessed on the evening of July 18, at about eight o'clock. We were near the little town of Eatonville, about thirty miles west of Mount Rainier, Washington, and in the timber. For a short time I could dimly discern five bows, or principally bands of red and purple, under the primary, making six in that group, and two of the secondary. Not only was the number larger than I have ever before witnessed or heard of and the colors brighter, but all of them were almost perfect semicircles, being complete throughout. We had no instruments for measuring, but a gradual decrease in width and brightness, like the bands in "Newton's rings," was quite apparent.

H. C. TILLMAN.

Puget Sound University, Tacoma, Wash., August 30, 1898.

Theory of the Manner in which the Sounds of Flue Organ Pipes and all Classes of Reed Wind Musical Instruments are Produced.

To the Editor of the SCIENTIFIC AMERICAN:

It is, I believe, the general if not universal opinion that all sounds are produced by vibrations which are conveyed to the ear by the atmosphere. How those vibrations are started and kept up has not been explained to me in a satisfactory manner.

Helmholtz, in his work, "Sensations of Tone," Part 1, Chapter 5, states that the stream of air in a flue organ pipe is directed across the sound hole and against its sharp edge, producing sounds which may be considered as a mixture of several inharmonic tones of nearly the same pitch. When the air chamber of the pipe is brought to bear upon these tones, its resonance strengthens such as correspond with the proper tones of that chamber, and makes them predominate over the rest.

In Appendix 19, Part H, Chapter 6, of the same work, a different theory is propounded by Mr. Herman Smith and Herr H. Schneebeli. Smith claims that the stream of air does not impinge against the sharp edge of the sound hole, that vibrations are produced by a form of "aero-plastic reed," which is formed outside the pipe, and bends partly within it, and that this reed acts similarly to the reeds of other wind instruments in the following manner: "The stream of air exhausts the air back of the reed, as shown in the atomizer drawing up a stream of liquid, thus effecting a vacuum, alternated by a pressure from the air rushing in, and causing a vibration of the reed."* This hardly seems plausible when we consider that some notes of a wind instrument require over 4,000 vibrations per second. It seems impossible that in a body as elastic as air this number of vacuums could be made and filled in a second, and that the opening or closing of the lateral holes could change the pitch of the sounds produced.

This theory of Smith's is the only one I have seen that attempts to explain how such vibrations are caused, but this only applies to the flue pipes of an organ, to the flageolet, or to the flute. Neither will it explain how the wind causes the strings of an Æolian harp to vibrate.

Doubtless you have often noticed that in the time of a freshet, when a stream has overflowed its banks, some twigs and bushes that are almost buried in the water and in the current of the stream are in constant vibration. This vibration is not governed by the velocity of the current as much as by the length and elasticity of the vibrating portion, for different twigs exposed to currents of the same velocity may vary in the rapidity of their vibrations. Another peculiarity is that the vibrations are not with and against the current, but transversely across the current. I believe that the same laws which produce vibration of a twig in a current of water produce the vibration of the Æolian string in a current of air.

The theory which I now advance is based upon the supposition that a peculiarity that is known to exist in any fluid in motion will be found in any other fluid. The action I now refer to may easily be seen in a thick, viscid liquid like tar or thick molasses. If you let a thin stream of such a liquid fall on a fixed body, you will at once see that the lowest portion of this stream bends back and forth, in what I call a lapping manner, some four or five times a second. I estimate that the mobility of pure water is thirty times greater than that of thick tar or molasses, that the vibrations would be thirty times greater, or from 120 to 130 times per second, and as the arc of vibration may be thirty times less, such vibrations would not be visible to the unaided eye.

To return to the stream of tar, if you allow it to fall on a piece of board, and at the same time move the board, the lower part of the stream will cease lapping and string out to one side like a kite string. If you reduce the speed of the board to a certain velocity, the lapping will commence, but the laps will be unequal, the long legs will be in the same direction the board is moved. In the case of the vibrating twig or Æolian string it is only that portion of the current that is about to impinge or has impinged against the twig or string that is caused to lap and to push the twig or string until its elasticity arrests and reverses its motion. The moment the retrograde motion commences the long laps change to the opposite side and assist the elasticity to move the twig to and past its normal position. I estimate that the vibrations of a stream of air impinging against a fixed body will be thirty times that of water having the same velocity, or from 3,600 to 4,500 vibrations per second; and if the velocity of the air is doubled or tripled, the vibrations will be increased in the same ratio, making the vibrations greater than necessary to produce the highest note that can be made on any wind instrument.

In the common whistle, flue organ pipe, flageolet, flute, and similar instruments, it is the lapping of the stream of air when it strikes the outer lip of the sound hole that puts in vibration the column of air within the pipe or tube and produces the sound. The moving of the sound wave within the pipe is governed by the length of the column of air, and this movement of the sound wave has the same effect on the lapping of the stream of air as the moving of the board has on the lapping of the stream of viscid liquid, and shows why the pitch of a flue organ pipe is governed by the length of the column of air above the sound hole, and how the opening and closing of the lateral holes of the flute make it possible to produce the chromatic scale.

In the free and beating reed class of instruments the current of air is in the same plane as the flat or inside surface of the reed. Whether the friction of the air against the inside surface of the reed or that which impinges against the edge of the reed causes the lapping or whether the two opposite currents from both sides of the reed impinge against the other and cause a lapping is not material. I think it is one of the three, or perhaps all of the three, that produces the lapping that causes the reed to vibrate. In the double reed the current of air impinges against the edges of the reed, or the friction against the inner walls of the reed causes a lapping and the reed to vibrate.

Some writers think that the lips of the player on a horn act similarly to a double reed, or, in other words, form a double reed. There is no doubt that they do vibrate with great rapidity. Regarding the lips as a double reed, it is the friction of the air against the lips that causes the stream of air to lap, which sets the column of air within the horn in vibration.

E. H. HAWLEY.

Washington, D. C.

* For a fuller description of Mr Smith's theory, see Nature, Vol. 8, pp. 25, 45; Vol. 9, p. 301; Vol. 10, pp. 161, 481; Vol. 11, pp. 325, 425; Vol. 12, p. 145; and Vol. 13, p. 571.

Armor on Warships.

To the Editor of the SCIENTIFIC AMERICAN:

I have been much interested in the accounts of our navy and its armament given in your SUPPLEMENTS.

According to them, the Harvey armor has an extremely hard face, but the hardening process only affects the steel for an inch or two in from the surface, and the rest of the plate has no more resisting power than so much tough steel. At first, when the projectiles struck the hardened face, their points were shattered and they failed to get through. This was met by protecting the point of the projectile with a soft steel cap which kept the point from breaking up, thus allowing it to penetrate the armor.

Were the armor to consist of two plates of the Harveyized armor, set one behind the other with an air space between them, would not these results follow?

First.—The projectile would have twice the depth of hardened steel to penetrate and a less thickness of armor would be required for the same resistance.

Second.—The soft cap would disappear from the projectile on its impact with the outer plate, and it would have to penetrate the second plate without the advantages accruing from the soft cap.

Third.—The lightening of the vessel. Such a double, or even treble system would reduce the aggregate thickness of armor, and give opportunity for a heavier armament or larger coal supply.

The space between the layers is evidently important, as guarding against the possibility of the outer plates taking the place of the soft cap in enabling the projectile to pierce the second.

I should feel obliged if you can express an opinion on the subject, either by letter or your correspondence columns.

C. W. KELLOGG.

Vineland, N. J., September 2, 1898.

[The system of disposing the armor in two separated walls is nothing new, for it is adopted in such vessels as the "Brooklyn" and "New York," where a projectile would first encounter a belt of vertical armor and then a wall of inclined armor, forming what is known as the "slopes" of the armored deck. The theory of this system of distribution is correctly stated by our correspondent.

The space between belt and sloping deck is devoted to coal bunkers, and the coal would assist in bursting and scattering and checking a shell before it reached the deck armor.—ED.]

Miscellaneous Notes and Receipts.

Green patina on zinc roofs which lasts for years is produced in the following manner: Cleanse the zinc of all dirt and coat it repeatedly with a diluted solution of copper nitrate. When the whole roof has been thus coppered over, cover it with a likewise diluted solution of carbonate of ammonia. On this coat of copper, patina readily forms.—Maler Zeitung.

Highly Expansive Enamels.—Mr. Saglio reports to the Société d'Encouragement de l'Industrie Nationale the results of his researches on highly expansive enamels, which are as follows: 1. That silica, kaolin, petalite, and zircon impart to the enamel infusibility and insolubility, but lessen the expansiveness. 2. That calcic phosphate increases the expansiveness, gives viscosity to the enamel in fusion and imparts to it a certain insolubility. 3. That cryolite, fluorspar, and, above all, rutile (which seems to fix the boracic acid well), increase the expansiveness and the fluidity of the enamel.—Moniteur de la Bijouterie, etc.

Absolute alcohol has, up to now, been produced by treating ordinary alcohol with calcium chloride or caustic lime or barium oxide, etc., which substances remove the water from the alcohol. These processes are rather tedious and also entail a considerable loss. As reported by the Färben Zeitung, absolute alcohol can be obtained in a very convenient way by introducing calcium carbide into the ordinary alcohol. The latter is strongly attacked by the water contained in the alcohol, and acetylene is formed as long as water is present. For the separation of the resulting lime and the calcium carbide not attacked, the alcohol is subsequently evaporated. On the other hand, calcium carbide may be employed as a reagent, by means of which may be ascertained whether any more water is present in the alcohol or not.

The Japanese Wood Oil.—According to Emil K. Blumme, the Japanese wood oil is, both in China and Japan, principally obtained in large quantities by expressing the seeds of Aleurites cordata, and is utilized as lacquer as well as for illuminating purposes. Efforts were made to introduce it into Europe, and it might successfully be employed in the manufacture of lacquer and oil paints. It was examined by Cloëz about twenty years ago and recently by Davies and Holmes. It consists of oleine (red oil) and elaeomargarine (a glyceride of the acid $C_{17}H_{30}O_3$). The tree yielding the oil is in China called "ying tzu tung" (ying-bottle), on account of the bottle-shaped fruits. Aleurites cordata attains to a height of 20 to 25 feet, grows in rocky ground, and is chiefly found in Hunan, Hupeh, and Szechuen. The fruit, which contains from five to seven large, poisonous seeds, from which the oil is pressed, is gathered in August and September and sent to Hankow. The oil is obtained in the following manner: The dried nuts are thrown into a flat dish of about two feet diameter, and roasted over direct fire. They are next pulverized between stones, and squeezed in wooden presses, whereby the oil exudes, which is then strained. After the nuts have been freed from the oil, they are charred in China, thereby furnishing a valuable soot, which is utilized in the manufacture of "India ink." The oil, when freshly prepared, is said to be exceedingly poisonous, and is used for adulterating the Gurjun balsam (from Dipterocarpus turbinatus). Two sorts of wood oil, to wit, Canton oil and Hankow oil, are distinguished in China.

Glacial acid produced a turbidity at 47° C. When 5 grammes oil are mixed with 2 c. cm. sulphur chloride (S_2Cl_2), to which are added 2 c. cm. carbon disulphide (CS_2), the mixture congeals, after one and one-half minutes, into a thick, sticky paste, at ordinary temperature. This paste is not as hard as that obtained from castor or linseed oil. If 4 grammes of the oil are heated in a capsule 7 cm. wide, a film forms on the edge after fifteen minutes, and after two hours it is so thick that by reversing the capsule no oil will escape. The increase of weight was during an exposition of four hours—0·36 per cent an hour. When heating the oil with argentic nitrate ($AgNO_3$), a red-brown color ensued after fifteen minutes. Concentrated sulphuric acid produced a black lump in the oil, while nitric acid (D = 1·4) converted the oil, after two minutes, into a firm lump, which became dark and friable afterward.

If 1 gramme oil is dissolved in 5 c. cm. chloroform, and 5 c. cm. of a saturated solution of iodine in chloroform are added, a thick paste forms after a few minutes, while diligently stirring the mixture.

Analysis has furnished the following values:

Density at 15 5° C.	0·8385
Congealing point, abont	17° C.
Hübl's iodine No.	165·7
Saponification No. (mg. of KOH)	194
Hehner No. (insoluble fatty acids)	96·4 per cent.
Non-saponifiable parts	0·44 per cent.
Reaction of the specific temperature	372
Free fatty acids	3 84 per cent.

The mixture of fatty acids showed:

Congealing point.	37° C.
Melting point	37° C.
Hübl's iodine No.	150·1

—Chemiker und Techniker Zeitung.