ELECTRIC INDUCTION BY STRESS.

Joule has shown that when a bar of iron is magnetized by means of a helix and electric current the bar is elongated appreciably. These elongations have been measured by Prof. E. A. Dolbear.

While undertaking some experiments in December, 1878, it occurred to me that the inverse of this ought to be true, namely, the forced elongation of a bar of iron, surrounded by a helix, would give cause for an electric current through the helix and connections. A series of experiments followed which completely verified the supposition, a recital of which may be of interest. The publication of them was deferred from time to time in the hope of more varied experiments, and in the possible discovery of like experiments by others.

By placing one branch of a sounding tuning fork near the pole of an electro-magnet, the coil of the latter having a Bell telephone in circuit, the tone of the fork is found to be reproduced in the telephone. But this is like using a Bell telephone for a transmitter, the branch of the fork in the present case serving for an armature, as does the diaphragm in that instrument. Again, when an iron bar is fastened at its center and made to vibrate longitudinally near an electro-magnet, a telephone in circuit will speak, and for the same reasons as before. Remove the core of the magnet and the sound is still heard at the telephone, and it is not necessary that the bar be a magnet. Bars of iron were selected that possessed a minimum amount of magnetism, in fact an almost inappreciable magnetism, and still a loud sound was emitted by the telephone.

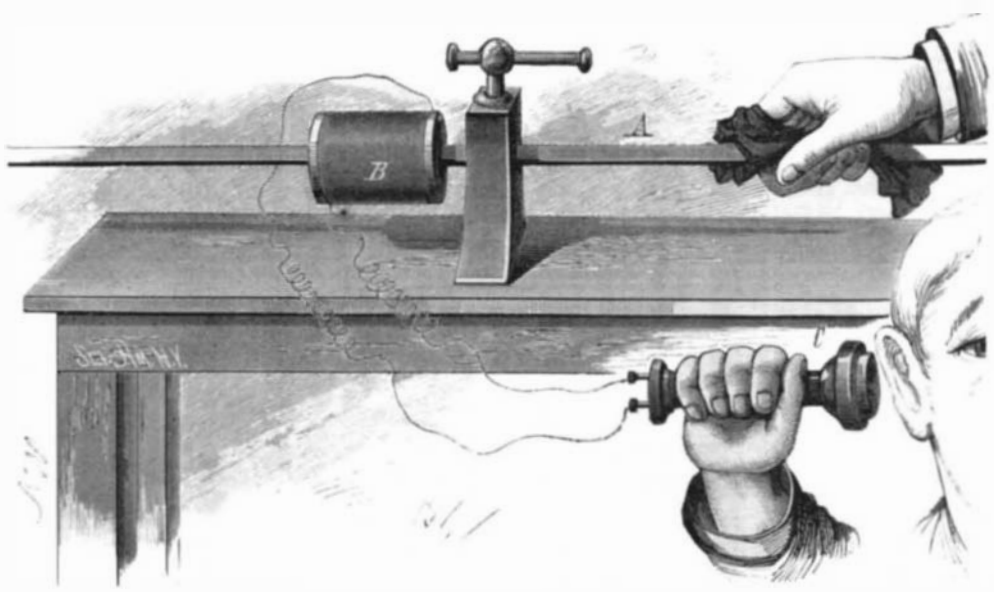
The helix used had no iron about it when the core was removed, and the opening for the core was large enough to encompass the bar without touching it. The bars used were several times the length of the helix.

At first it was supposed that the *motion* of the iron longitudinally was chiefly concerned in the production of sound. On this supposition the sound would diminish as the helix was moved toward the middle of the bar where it was firmly secured in a clamp for longitudinal vibration. But instead of this, the intensity was increased; and to such an extent that the auditor at the telephone in a distant room could positively say whether the coil was at the end or at the middle of the longitudinally vibrating bar. This made it clear that the sounds observed were not to be explained altogether on the ground of vibratory motion of the particles of the bar, because the motion of the bar at its middle is *nil* when clamped at this point and vibrating longitudinally at its fundamental; while at the ends we have a maximum degree of vibratory motion. But at the middle of a bar thus conditioned we have a node, and the strains are here known to be those of extension and compression and at a maximum for the bar, while at the ends the alternating strains are *nil;* that is, where the motion is greatest the strains are least, and *vice versa.* It seems, therefore, certain that at the middle the sound is chiefly due to the vibratory stresses, while at the ends it is almost entirely due to motion.

The engraving shows the apparatus. Rods were used which were from one-quarter to one-half inch in diameter and three feet long The coil was about three inches long, and so connected with the free circuit wires that it could readily be moved along the rod. As the clamp prevented placing the coil exactly at the middle of the bar, the latter, to test this point, was taken out and suspended by two filaments so light as not to interfere with the vibration, and the bar made to vibrate longitudinally by striking on the end with a mallet. The coil was placed directly at the middle and also shifted to right and left, but the sound was still loudest at the middle. Sounds produced by the transverse vibrations, now accidentally occurring and mixing with those due to the longitudinal vibrations, were heard, but were readily distinguished by the pitch of tone. These were separated from the above consideration of longitudinal vibrations.

To further test the matter of electric induction by stress, a rod was passed through the coil, and the rod put under tension in a testing machine. A galvanometer now placed in the circuit became very active as the strain was put on. The bar was an ordinary three-eighths rod of commercial bar iron. It was at once found to be permanently stretching, and the galvanometer needle was all the while flying about as the extension continued. When the bar was removed it was found to be strongly magnetic, much more so than it could have been when put in. It was also heated. It therefore seemed difficult to determine whether the observed currents of electric induction were due to strain, stretch, magnetism, motion, or heat, in part or together.

A piece of white chilled cast iron was then tested to 42,000 lb. compression, and found to resist the full power of the machine without crushing or set. The coil was then placed around the rod, and the test for stress-electric induction applied. Under compressive strains the needle gave unmistakable evidence of electric currents, though they were much feebler than in the previous case of soft iron.



MANNER OF PRODUCING ELECTRIC INDUCTION BY VARYING STRESS.

Experiments on steel bars, not magnetized, gave appreciably the same effects as iron bars. Magnetized steel was not tried, but it is presumed that at the end of the bar magnet vibrating longitudinally the sounds would be intensified, while at the middle of the bar, normally magnetized, the sounds probably would not materially differ from those obtained from non-magnetic bars.

A few other metals were tried, copper and brass particularly, but no sounds were heard from them. These experiments, though far from being complete and exhaustive of the subject, warrant us in the following conclusions, namely:

1st. That the fact of Joule, of the distortion of bars of iron by magnetization with electric currents, is operative in the inverse order, namely, distortion of bars by mechanical force induces electric currents in surrounding coils.

2d. Most other metals than iron or steel give but feeble if any observable results of stress-electric induction.

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RECENT INVENTIONS.

An improved tip for lamp-wick tubes has been patented by Mr. Hamilton B. Follett, of Brooklyn, N. Y. The object of this invention is to produce a very brilliant and regular flame in a kerosene lamp or stove, and to prevent any irregular or undue carbonizing of the wick. It consists in a small plate of metal, which passes edgewise and longitudinally over the middle of the upper edge of the wick tube, a short distance above.

Mr. Alfred I. E. Knight, of New York city, has patented a convenient inkstand or cabinet constructed with means for holding pen holders, sponges, rules, etc., and also a central removable panel, ornamentation, or calendar, and formed with surfaces adapted for emblematical or lettered advertising.

An improved apparatus for stowing cotton bales in vessels has been patented by Mr. John F. Taylor, of Sharon Springs, N. Y. The object of this invention is to facilitate the stowing of cotton bales in vessels, and enable the stevedores to stow a much greater quantity in a vessel than is possible when the stowing is done in the ordinary manner.

Mr. George Hill, of White Hall, Ill., has patented an improved stew pan which can stand very intense heat without breaking, has a support that admits of a circulation of air under the vessel, and has ears for fastening the bail, which are so protected that they cannot be broken off by slight jars or shocks, as is the case with the ears of the ordinary earthenware pan.

Pocket scales designed especially for physicians practicing in the country and in small towns, where it is necessary for them to carry and weigh out their medicines, for family use in weighing medicine, and for prescriptions and other delicate weighing, have been patented by Mr. Isaac S. Hopkins, of Oxford, Ga.

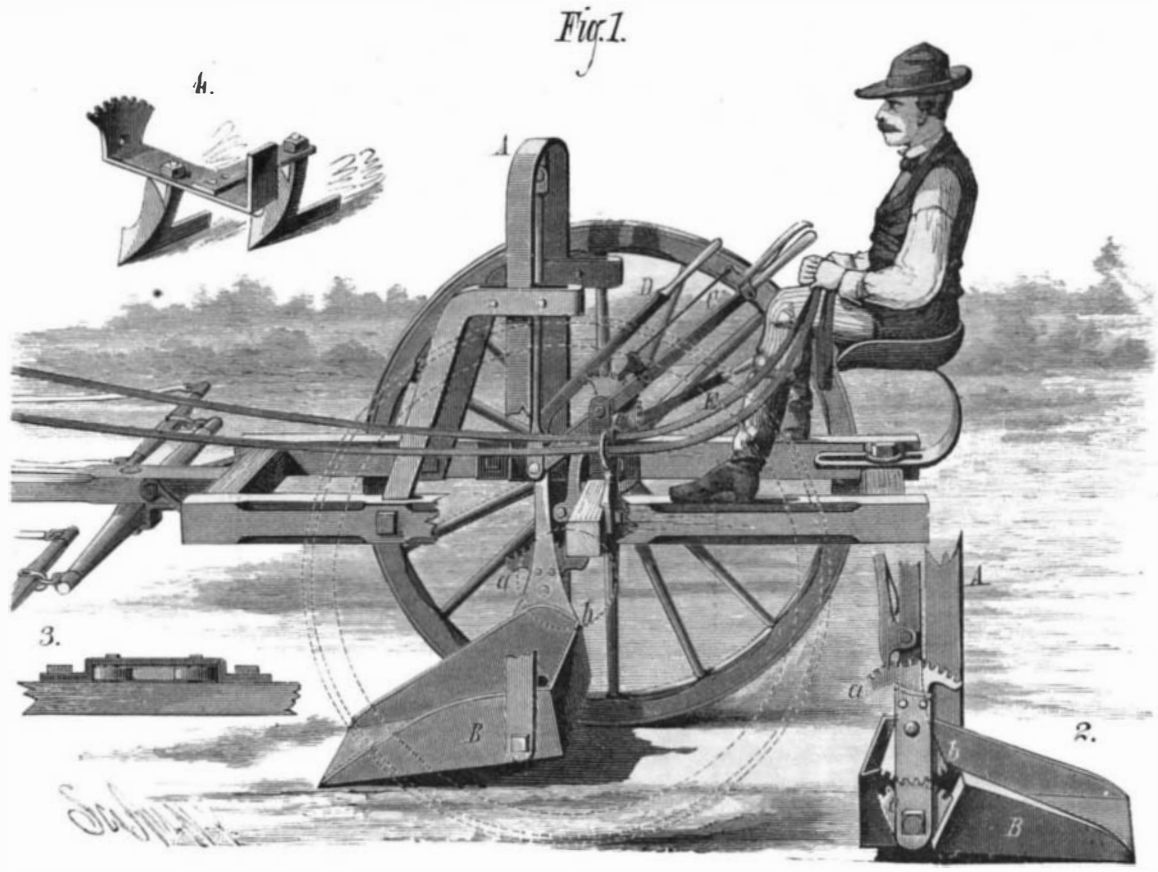
An improved device for testing milk by comparing its color with a scale of shades of colors, has been patented by Mr. Friedrich Heeren, of Hanover, Germany.

An improved last, for the manufacture of boots and shoes, has been patented by Messrs. John Martin and Josiah Merrill, of Great Falls, N. H. It can be changed to suit the style at a small cost.

NEW ROAD SCRAPER.

We give herewith an engraving of an improved road scraper for moving dirt from one locality to another and for leveling and grading. It is mounted on wheels and is provided with levers, by means of which every movement of the machine may be readily controlled by the driver, who sits on the seat at the rear of the main frame.

Fig. 1.



AGEE'S ROAD SCRAPER.

For the sake of showing the working parts of the machine one of the supporting wheels is removed, and parts of the framing are broken away.

A forked frame, A, is guided in roller bearings in the main frame and in the braces extending upward from the frame, and has pivoted between its lower ends the scraper, B, which is made either wholly or in part of iron or steel. A lever, C, is fulcrumed on a standard attached to the axle, and is connected with the upper part of the forked frame, A, by means of a connecting rod, so that the support may be moved up or forced downward as occasion may require. The lever, C, is provided with a pawl which drops into a toothed sector attached to the lever support, and holds the frame, A, at any desired height.

A toothed sector, *c*, is secured to the side of the scraper, and is engaged by another toothed sector, *b*, pivoted to the frame, A, and extended upward and backward, forming the lever, D, and the latter carries a toothed sector, *a*, which is engaged by a pawl pivoted to the side of the frame, A, and extended upward and rearward, terminating in the handle. This pawl locks the scraper securely at any desired angle that is in position to scrape up the earth, or with the edge elevated in position to retain the earth. It will be seen that with mechanism thus arranged the driver

can, without difficulty, depress the scraper and hold it, or he can raise it and hold it, or manipulate it in any desired way without a great deal of exertion.

Fig. 2 shows the details of the mechanism for operating the scraper. Fig. 3 shows the roller guide for the frame, A, and Fig. 4 shows a plow attachment that may be used in place of the scraper for loosening the soil preparatory to removal by the scraper. One of the plows is secured directly to the pivoted bar, and the other is secured to a short beam extending backward. These plows are raised, lowered, and tipped in one direction or the other by the levers used to operate the scraper. If desired, a single plow may be attached to the center of the pivoted bar.

The merits of this device will be appreciated by any one having had much experience with ordinary scrapers.

Further information may be obtained by addressing the inventor, Mr. G. S. Agee, Mint Hill, Osage county, Mo.

Elasticity Viewed as Possibly a Mode of Motion.

At a recent meeting of the Royal Institution, Sir Willim Thomson, LL.D., F.R.S., etc., said, with reference to the title of his discourse: "The mere title of Dr. Tyndall's beautiful book, 'Heat a Mode of Motion,' is a lesson of truth which has manifested far and wide through the world one of the greatest discoveries of modern philosophy. I have always admired it; I have long coveted it for elasticity; and now, by kind permission of its inventor, I have borrowed it for this evening's discourse.

"A century and a half ago, Daniel Bernouilli shadowed forth the kinetic theory of the elasticity of gases, which has been accepted as truth by Joule, splendidly developed by Clausius and Maxwell, raised from statistics of the swayings of a crowd to observation and measurement of the free path of an individual atom in Tait and Dewar's explanation of Crookes' grand discovery of the radiometer, and in the vivid realization of the old Lucretian torrents with which Crookes himself has followed up their explanation of his own earlier experiments; by which, less than two hundred years after its first discovery by Robert Boyle, 'the Spring of Air' is ascertained to be a mere statistical resultant of myriads of molecular collisions.

"But the molecules or atoms must have elasticity, and *this* elasticity must be explained by motion before the uncertain sound given forth in the title of the discourse, 'Elasticity Viewed as Possibly a Mode of Motion,' can be raised to the glorious certainty of 'Heat a Mode of Motion.'"

The speaker referred to spinning tops, the child's rolling hoop, and the bicycle in rapid motion as cases of stiff, elastic-like firmness produced by motion, and showed experiments with gyrostats in which upright positions, utterly unstable without rotation, were maintained with a firmness, strength, and elasticity as might be produced by bands of steel. A flexible endless chain seemed rigid when caused to run rapidly round a pulley, and when caused to jump off the pulley, and let fall to the floor, stood stiffly upright for a time till its motion was lost by impact and friction of its links on the floor. A limp disk of India-rubber caused to rotate rapidly, seemed to acquire the stiffness of a gigantic Rubens' hat brim. A little wooden ball, which, when thrust down under still water, jumped up again in a moment, remained down as if embedded in jelly when the water was caused to rotate rapidly, and sprang back as if the water had elasticity like that of jelly when it was struck by a stiff wire pushed down through the center of the cork by which the glass vessel containing the water was filled. Lastly, large smoke rings, discharged from a circular or elliptic aperture in a box, were shown, by aid of the electric light, in their progress through the air of the theater when undisturbed. Each ring was circular, and its motion was steady when the aperture from which it proceeded was circular, and when it was not disturbed by another ring. When one ring was sent obliquely after another, the collision or approach to collision sent the two away in greatly changed directions, and each vibrating seemingly like an India-rubber band. When the aperture was elliptic, each undisturbed ring was seen to be in a state of regular vibration from the beginning, and to continue so throughout its course across the lecture room. Here, then, in water and air was elasticity as of an elastic solid, developed by mere motion. May not the elasticity of every ultimate atom of matter be thus explained? But this kinetic theory of matter is a dream, and can be nothing else, until it can explain chemical affinity, electricity, magnetism, gravitation, and the inertia of masses (that is, crowds of vortices).

Le Sage's theory might easily give an explanation of gravity and of its relation *to inertia of masses*, on the vortex theory, were it not for the essential allotropy of crystals, and the seemingly perfect isotropy of gravity. No finger post pointing toward a way that can possibly lead to a surmounting of this difficulty, or a turning of its flank, has been discovered, or imagined as discoverable. Belief that no other theory of matter is possible is the only ground for anticipating that there is in store for the world another beautiful book to be called "Elasticity a Mode of Motion."

Drawings of Washington Monument Memorials.

A series of drawings of the various memorial stones contributed to the Washington Monument at Washington, was made thirty-one years ago, during leisure intervals, by Roger Williams Wilcox, then a young patent-model draughtsman. He died the following year; but his sketches were carefully treasured by his mother; and now in her old age they have been purchased by the Monument Association.

The stones form the inner walls of the memorial chamber in the base of the great monument. Many of the stones are of costly character, with highly wrought emblems and inscriptions upon them. The drawings are of especial value, because they represent the individual stones as they appeared soon after arrival in Washington, and before they were set up within the monument.

PORCELAIN URN.

Nothing is more beautiful than some of the richly ornamented pieces of pottery turned out of the factory at Sevres. The engraving shows a fine specimen of Sevres porcelain

PORCELAIN URN FROM KENSINGTON MUSEUM.

preserved at the Kensington Museum. It is remarkable for the elaborateness of its design and the delicacy with which it is treated in every part.

Stress and Strain.

At a recent meeting of the Royal Society, a paper on "The Influence of Stress and Strain on the Action of Physical Forces," was read by Prof. W. Grylls Adams, M.A., F.R.S. It was Part I., and related to elasticity: "Young's Modulus." A large number of experiments with different loads were made, and after many unsuccessful attempts to account for certain discrepancies which could not be explained away as errors of observation, the following facts were elicited:

1. After a wire has suffered permanent extension, the temporary elongation which can be produced by any load becomes less as the interval between the period of permanent extension and that of applying the load becomes greater.

2. This increase of elasticity is greater in proportion for large loads than for small ones.

3. The increase of elasticity takes place whether the wire be allowed to remain loaded or unloaded between the period of permanent extension and that of the testing for the elasticity.

4. The rate of increase of elasticity varies considerably with different metals; with some the maximum elasticity is apparently attained in a few minutes and with others not till some days have elapsed, iron and steel being in this last respect very remarkable.

5. The elasticity can also be increased by heavily loading and unloading several times, the rate of increase diminishing with each loading and unloading.

6. A departure from "Hooke's law" more or less decided always attends recent permanent extension, even when the weights employed to test the elasticity do not exceed one-tenth of the breaking weight.

7. This departure is diminished very noticeably in the case of iron, and much less so in the case of other metals, by allowing the wire to rest for some time either loaded or unloaded; it is also diminished by repeated loading and unloading.

The effect of permanent extension on the value of "Young's modulus" was tried according to the direct method for iron and copper, and indirectly for most of the metals.

Steam Whistles in a Fog—Curious Phenomena.

Captain Shirley, of the steamer City of Lawrence, of the Norwich and New York Transportation Company's line, reports a strange phenomenon on the Sound during foggy nights, which is worthy the investigation of scientific men. He says that when the steamer City of Lawrence was three or four miles east of Stratford Shoals light, on the night of the 12th May, he heard a whistle which sounded off the starboard bow. He blew the whistle of his boat several times, giving two blasts each time, but could get no reply. He stopped his boat, blew three whistles, and was delayed some three minutes, when the steamer State of New York suddenly appeared, blew two whistles, and passed him on the left. On the same night, when near Faulkner's Island, the State of New York whistled to the north of the Lawrence. She blew two whistles, and the New York returned one blast, and she passed to the southward. Capt. Shirley did not hear her whistle from the time that he heard her first blast until she passed him. Whistles were heard to the eastward, but not to the westward that night.

Sunday night, when the Lawrence was two miles from Bartlett Reef lifeboat, the bell was heard plainly, but when the Lawrence had got within a mile of the lifeboat they lost the sound until within an eighth of a mile of it, when they saw the glimmer of the light. The same phenomenon occurred off the Cornfield light.

The water was calm, and a light northeasterly breeze was blowing. When off Huntington, on the same night, Captain Shirley heard a whistle blow four or five times. It then grew fainter and fainter, until it could be no longer heard. He thought that it was a steamer going away from him. After running for two or three minutes, he heard a whistle close ahead on the starboard bow. The Lawrence blew three whistles and backed, and had to hail a large tug with barges in tow to leave their helm to their starboard to prevent a collision. The tug passed the Lawrence with but ten feet of lee room. Capt. Mott, an old Sound navigator, remembers the occurrence of similar phenomena on the night of the collision between the steamers Stonington and Narragansett, in June, 1880.

Why the sound of whistles is not conveyed as well on a foggy night as on a clear one is a problem to be solved. It cannot be attributed to head winds or heavy seas, for the sea was calm and the air almost motionless. The signals at Huntington and Execution lights have been heard over fifteen miles against a northeast gale. The navigators of the Sound are anxious to have the phenomena explained.—*Norwich (Conn.) Bulletin.*

Elevated Railroads.

Elevated railroads are now entitled to rank among American institutions, and in the future will call for a large consumption of iron. There are, according to the *Iron Age*, three schemes of this character under discussion in St. Louis, and the only question is which shall be adopted. Philadelphia is making good progress in following the example of New York. Brooklyn encounters an obstacle, partly arising from the configuration of the surface, which favors the construction of tunnels, but the city is in desperate need of some form of rapid transportation. Boston hesitates, apparently on account of objections to architectural disfigurement. But elevated railroads in all our large cities is only a question of time for while individual pieces of property may be injured by their propinquity, millions are added to the aggregate assessable value, and their convenience is beyond calculation.

The latest phase in New York is the employment of elevated roads for the transportation of freight. By no other method yet contrived can the jam of vehicles on our water front be relieved.