SIMPLE EXPERIMENTS IN PHYSICS.

BY GEO. M. HOPKINS.

Impulses which, occurring singly or at irregular intervals, are incapable of producing any noticeable effects, may, when made regularly, under favorable circumstances, yield astonishing results. The rattling of church windows by air waves generated by a particular pipe of the organ, a bridge strained or broken by the regular tramp of soldiers or by the trotting of horses, the vibration of a six or eight story building by a wagon rumbling over the pavement, a factory vibrated to a dangerous degree by machinery contained within its walls, a mill shaken from foundation to roof by air waves generated by water falling over a dam, are all familiar examples of the power of regular or harmonic vibrations.

Harmonic vibrations result from regularly recurring impulses, which may be very slight indeed, but when the effects of the impulses are added one to another, the accumulation of power is sometimes very great.

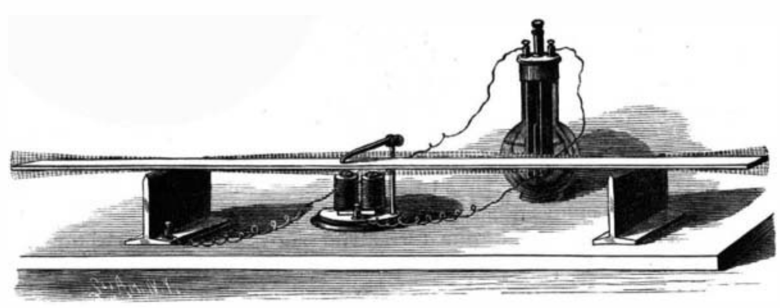
To secure cumulative effects, the impulses must not only be regular in their occurrence, but the body receiving the impulses must be able to respond, its vibratory period must correspond with the period of the impulses And further than this, the impulses must bear a certain relation to a particular phase of the vibration, in order that they may act upon the vibrating body in such a way as to augment its motion rather than diminish it.

There are railroad bridges that vibrate alarmingly when crossed by locomotives running at a certain speed, the vibrations being caused by the comparatively slight lack of balance in the driving wheels and connecting rods. For this reason the speed is restricted on such bridges.

During the early tests of the East River bridge between New York and Brooklyn it was found that the structure was so massive and its vibratory period so slow that it could not be injuriously affected by the marching of men or the trotting of horses; consequently, travel proceeds on this bridge as upon any highway.

A well known English physicist is reported to have said that with suitable appliances he could break an iron girder by pelting it with pith balls. An experiment of this kind would certainly show in a striking manner the effects of very slight rhythmic impulses. As it is manifestly impracticable to perform such an experiment, an easier method of illustrating harmonic vibrations must be sought.

In the accompanying engravings, Fig. 1 shows how a bar of steel may be set in active vibration by drops of water. The bar is supported at nodal points upon angular pieces of wood. Above the center of the bar is arranged a faucet, which communicates with the water supply. The bar is first vibrated by hand, and the faucet is adjusted so that the water drops in unison with the vibrations of the bar. The motion of the bar is then stopped, and the water is allowed to drop on it. The bar soon begins to vibrate, and in a short time the vibration acquires considerable amplitude.



Fi . 2.—VIBRATION BY MAGNETIC IMPULSE.

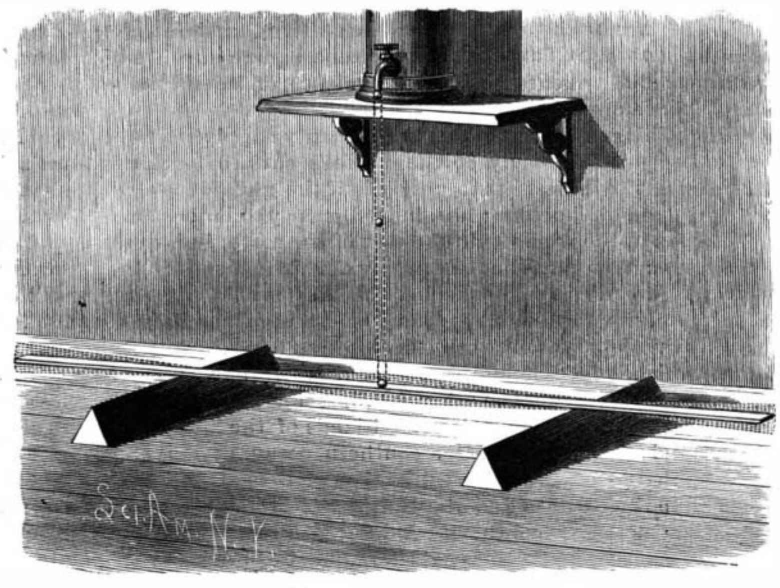


Fig. 1.—HARMONIC VIBRATION.

In Fig. 2 is shown an experiment in which the intermittent pull of an electro-magnet is made to accomplish the same thing. In this case the steel bar forms a part of the circuit. The magnet is provided with a light wooden spring-pressed arm, carrying a contact point and a conductor. This arm is arranged to follow the bar up and down through the upper half of its excursion, breaking the contact at the median position of the bar. The magnet becomes alternately magnetized and demagnetized, and the bar is alternately pulled down and released. The bar used in these experiments is ¼ in. thick, 1¼ in. wide, and 8 ft. long. A much larger bar might be used. Without doubt, even an iron girder of great size and weight might be set in active vibration by the same means.

THE NEW DIEULAFOY HALLS AT THE LOUVRE.

Our readers will remember that we several months ago published an account of the travels of Madam Jane Dieulafoy, the young and intrepid explorer, who shared with her husband the fatigue and perils of the interesting excavations made in Susiana by the expedition of which he had command.

Mr. and Mrs. Dieulafoy have deposited the curious collection brought back by them in that part of the Louvre that had been put at their disposal. An inauguration of the halls that will henceforth bear the name of their organizers took place quite recently. The objects exhibited therein were discovered at 1,300 feet from the Persian Gulf, in a country in which no roads are laid out, and in which means of communication are consequently wanting. The whole had to be transported on camel back to a distance of 240 miles. From this may be seen how difficult was the undertaking, and what energy had to be displayed for several consecutive years, in order to make it a success.

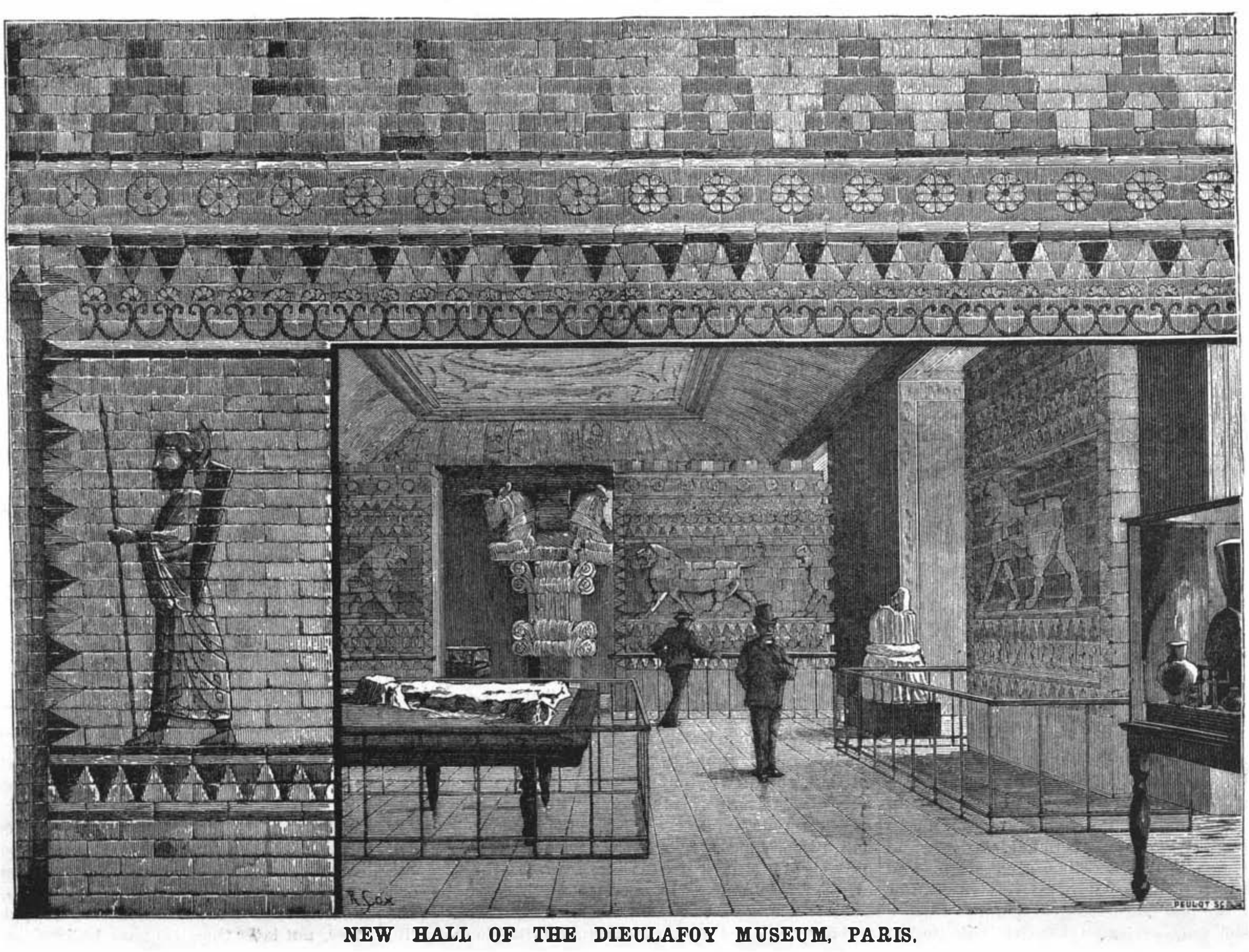
As may be seen from an examination of our engraving, the Dieulafoy halls contain some exceedingly curious objects. Among other things, there are fragments of walls, and even entire walls from the palace of Darius, and glazed bricks set off with ornaments of wonderful coloring. On one side we see lions, and on the other archers in profile holding their weapons in hand.

The sides of the two halls are hidden by these walls, the aspect of which is very pleasing and harmonious. Their facing is of a turquois blue color, and the black-visaged figures are clad in yellow and white, with the skirt escutcheoned with the three towers of Susa. In the rear of the museum we remark a colossal capital formed of oxen's heads.

The decoration of the halls in which are grouped so many interesting souvenirs of a vanished civilization is in the Persian style, and the ornamentation has been very conscientiously elaborated.

Clothed in the male costume that she usually wears, and a buttonhole decorated with the ribbon of the Legion of Honor, Madam Dieulafoy did the honors of the halls to the few privileged invitees who were present at the inauguration.—*Le Monde Illustre.*

NEXT to moral weakness, a fear of the difficulties to to be met is, undoubtedly, the most unfortunate mental trait of any young person.



NEW HALL OF THE DIEULAFOY MUSEUM, PARIS.

[FROM THE POPULAR SCIENCE NEWS.]

Our Neighbor Across the Way.

BY PROF. C. A. YOUNG.

The planet Mars occupies in the solar system the orbit next outside the earth's, and at times comes nearer to us than any other heavenly body, excepting only the moon and the planet Venus, or now and then a stray comet. But when Venus is nearest the earth, her illuminated surface is turned away; so that the moon alone offers better opportunities for telescopic examination than does Mars when, at its opposition, it is for a season the chief ornament of the evening sky.

The reader must not, however, imagine that, because the planet is then nearer than other heavenly bodies, its distance is really comparable with any geographical distances on the earth's surface. Even under the most favorable circumstances, the distance is never less than about 36,000,000 miles, which is about one hundred and fifty times that of the moon, and a century's railway journey for a "celestial limited," running 40 miles an hour, without stops. Even with a magnifying power of a thousand, which is about the highest that can be advantageously used on any but the very largest telescopes, and under exceptional circumstances, the planet is still optically fully 36,000 miles away, and shows in the field of view a disk about 6½° in diameter, upon which the smallest objects visible would need to be 25 or 30 miles across. A rather powerful field glass, with a magnifying power of six or seven, would bring the moon as near.

It is only about once in fifteen years that Mars comes as near as even 36,000,000 miles. Its orbit is so eccentric, that the interval between it and the orbit of the earth varies all the way from 36,000,000 miles to 61,000,000; and it is only now and then that, as the two planets circle round in their respective tracks, the passing point is where the tracks come nearest. The last instance of a very close approach was in 1877; the next will be in 1892.

Mars is much smaller that the earth, its diameter being only about 4,200 miles. Its bulk therefore is only about one-seventh, and its surface about three-tenths of the earth's.

By means of the motion of its swift little moons, it is easy to ascertain that its "mass" (*i. e.*, the quantity of matter it contains) is somewhat less than one-ninth of the earth's, and consequently its density is only three-fourths, and its superficial gravity just about three-eighths, of the earth's; *i. e.*, a body which at the earth's surface weighs 100 pounds, would weigh only 38 pounds there, and a force which here would project a body to an elevation of 100 feet would throw it there to a height of 265. This is a point of considerable importance in considering the physical conditions of the planet.

When examined by the telescope under favorable conditions, Mars is a very pretty and interesting object. It shows a ruddy disk, which, for some not certainly known reason, is much brighter at the edge than near the center; in this respect resembling Mercury, Venus, and the moon, but standing in marked contrast with Jupiter and Saturn. According to Zollner, the "albedo," or reflecting power, of its surface is about 26 per cent; that is to say, it reflects about 26 per cent of all the light which falls upon it—about as much as ordinary sand. This is considerably higher than the albedo of either Mercury or the moon, but only about half that of Venus or any of the major planets.

Just at the time of opposition the disk is of course perfectly circular; but at other times it is more or less "gibbous," like the moon a day or two from the full. It varies greatly in apparent size, according to the changing distance of the planet, which ranges all the way from 250,000,000 miles to 36,000,000.

The disk is mottled with spots and streaks, which are not arranged in belts with an evident relation to the planet's equator, as in the case of Jupiter and Saturn, but are distributed irregularly over the surface. A telescope of not more than seven or eight inches aperture shows them fairly well, and the more conspicuous of them can be seen with much smaller instruments. As we watch them, they drift across the disk from east to west, and many of them are so permanent and well defined, that by their help we can ascertain the length of the planet's day with very great accuracy. The latest and probably most precise determination is that of Bakhuyzen, who gives the time of rotation as 24 h. 37 m. 22·66 s. The only question is as to the odd hundredths of a second.

Most of the spots and markings are permanent, but not all. Bright patches are now and then observed which seem to be evanescent, like sheets of cloud that for a time conceal the oceans and continents beneath, and then rapidly clear away.

Such phenomena, of course, imply an atmosphere more or less like our own, and Dr. Huggins has confirmed the fact by a direct observation of the lines of water vapor in the planet's spectrum. But many things go to show that this atmosphere is much less dense and extensive than the earth's. On Mars great storms and widespread cloud veils are comparatively rare. For the most part the real features of the planet's surface are clearly seen, uncomplicated by overlying mists, while the surface of the earth at any given moment would probably be fully half obscured, as seen from the moon or Mars.

The planet's equator is inclined to its orbit at an angle of nearly 28°, and, as a consequence, Mars ought to have seasons much like those of the earth. One very beautiful phenomenon seems to show that this is actually the case. In the neighborhood of the planet's poles there are brilliant spots, evidently composed of some substance which reflects light very abundantly; and it is natural to think of ice or snow, because, as Sir W. Herschel observed a century ago, each spot grows larger when it is turned away from the sun, and dwindles in the summer, just as a polar ice cap would. It is worth noting that this snow cap, if such it really is, never comes down to middle latitudes, as does the wintry envelope of our terrestrial snow. In January "the man in the moon" would see pretty much all that portion of the earth's northern hemisphere which lies above 45° of latitude as one gleaming white expanse, unbroken except where the Atlantic and Pacific Oceans interrupt its continuity. Although Mars is so much further from the sun than the earth is, and receives less than half as much heat to each square mile of surface, it presents no such prevalence of ice in either hemisphere.

This can hardly be due to the scanty supply of water, because the study of the planet's surface markings seems to indicate that nearly half the globe is covered by seas and oceans; not, indeed, nearly so large a fraction of the whole as in the case of the earth, but quite enough to furnish a fair supply of rain and snow.

The northern hemisphere of Mars is of a comparatively uniform orange-colored tint, and is supposed to be mainly land, though it incloses certain dark spots, which, likely enough, are inland seas. The southern hemisphere, on the other hand, is for the most part darker, with here and there islands of the lighter colored surface. From this southern ocean, as it is supposed to be, great bays, like that of Bengal, and arms like the Red Sea and the Baltic, penetrate deeply into the northern continent; indeed, as Proctor long ago remarked, a very striking characteristic of Mars is the manner in which land and water are divided and intermeshed, there being on the planet no unbroken mass of land to correspond to the Asiatic continent, nor any ocean like the Pacific.

The principal features of the planet's geography (strictly areography) are now quite beyond question, and have been several times fairly mapped. Thus far, however, no satisfactory nomenclature has been settled. Upon Mr. Proctor's map the names assigned are mostly those of astronomers who have made contributions to our knowledge of the planet's topography. Thus we have the continents of Herschel, Dawes, Maedler, and Secchi, the oceans of Dawes and De la Rue, and the seas of Kaiser, Beer, and Delambre. Schiaparelli, on the other hand, with better taste, derives his names from ancient geography and legend. We have for the land masses, in the order before mentioned, Libya, Acria, Arabia, and Chryse. Syrtis Major replaces the Kaiser Sea (which is, on the whole, the most conspicuous object on the planet), and De la Rue Ocean becomes the Mare Erythræum. But while the principal features of the planet's configuration are thus fairly well made out, especially those near its equator, there is no such agreement in minor details, and the different maps are widely at variance. Schiaparelli, of Milan, who has had the great advantage of the Italian atmosphere, has introduced into his charts a great number of delicate objects, which have never been satisfactorily seen by others, though many partial confirmations have been obtained. In place of the comparatively ill-defined and hazy streaks seen here and there by other observers, he represents the northern hemisphere of the planet as covered by a network of fine, hair-like lines, which he calls "canals," and supposes to be water-ways. Some of these extend over 90° of the planet's circumference, or nearly 3,000 miles in length, with a width not to exceed 30 or 40 miles.

In Schiaparelli's map of 1877, which is the one usually copied in the text books, only a few of the canals appear, but on his more recent charts there are nearly sixty of them.

The most remarkable thing about them remains to be stated: In 1881 he found most of them to be *doubled;* the single lines which intersect the continental masses had almost without exception become *pairs* of parallels, like the two tracks of a railroad, with a very uniform distance of 150 or 200 miles between them. We say "had become," because it is his opinion that this "gemination" of the canals is a temporary phenomenon, depending somehow on the progress of the martial seasons.

These observations have naturally excited much discussion, and at present scientific opinion is considerably divided in regard to them. No other astronomer has been able to observe the canals in any such extent and perfection as Schiaparelli with his telescope of only eight inches aperture; but several others, especially Perrotin at Nice, have seen something of the sort, and furnish a partial confirmation of his work. The "gemination" of the canals is so remarkable and so inexplicable, that many are disposed to think the phenomenon a purely optical one, due to some astigmatism and imperfect focus of either the instrument or of the observer's eye; or else (as Mr. Proctor suggested rather vaguely) an effect of diffraction in some way. If it were not for the observations of Perrotin, I for one should accept the theory of astigmatism, for I have myself often seen delicate single lines in the solar spectrum appear double from some slight pinch of one of the lenses in the spectroscope. But it is very difficult to see just how two different observers, with two such different instruments as the twenty-nine inch telescope at Nice and the little eight inch at Milan, could see the phenomenon alike if it were merely optical. There is some mystery about the matter, and it is clear that we must wait for further and more conclusive evidence before building any considerable structure of theory upon the reported facts. The only suggestion so far made which seems worthy of mention here is that the "canals" may be watercourses of some sort, at times flooded, and at other times drained off, so as to become invisible.

During the last opposition (in April) the planet's nearest approach to the earth was about 56,000,000 miles, and it was so far south in the sky that it could not be very well observed in Europe or this country. But both at Milan and Nice some of the canals were seen, and seen as double for a time. Perrotin also reported that a continental tract which he had named Libya (a part of Proctor's "Herschel Continent") *had mostly disappeared, as if inundated.* While this observation of his is partially confirmed by some observers, it has been positively disputed by others. With the Lick telescope, Libya was seen last spring by Professor Holden on several occasions; in fact, whenever it was favorably placed for observation at the time the telescope happened to be directed on the planet. Nor was anything seen at Mount Hamilton like the "gemination" of any of the canals, though in some instances a widish streak was observed, in place of the sharp and narrow line delineated on the map.

The two little satellites (discovered by Professor Hall at Washington in 1877) were, of course, seen and easily observed.

It is to be hoped and expected that the great telescope on Mount Hamilton, with its advantages of situation and its freedom from the atmospheric embarrassments which so seriously interfere with the work of our other large instruments, will in 1890 and 1892 be able to solve definitely the interesting problems that our neighbor proposes for our investigation.

Princeton, Nov. 9, 1888.

A Forty-five Foot Bed of Salt.

Extensive explorations, continued through several years, and extending over a wide region in the upper part of the Onondaga Valley, about seventeen miles southward from the city of Syracuse, have been rewarded with complete success. Under the direction of William B. Coggswell, general manager of the Solvay Process Works, wells have been sunk in five different localities—one on the hill side at Jamesville, another at Cedarville, one near Onondaga Valley (village), one in the south part of the town of Lafayette, and now another in that town, also up the valley near Cardiff.

On the fourth trial full success was attained. The fifth, now in progress, promises a like result. In other instances salt water was found. The successful boring was at a point seventeen miles south of this city, on the easterly side of the valley at the foot of the hills. It was carried to a sufficient depth, and a solid bed of rock salt forty-five feet in depth was discovered. The boring was in the shales through 725 feet of the deposit, then through 500 feet of limestone, when, underneath and next to it, at a depth of 1,210 feet from the surface, a solid body of rock salt forty-five feet thick was reached. The boring was carried through the deposit. Operations were begun early in the season, but some obstacles were encountered, making necessary a change of location, when the work was prosecuted to this successful termination. The well now in progress is thirteen miles south of the city, four miles nearer than the place at which the "great find" was made, and there is every prospect of equally good results there, without the necessity of boring more than 1,000 feet. The process is expensive and laborious, and the Solvay Process Company has expended thereon not less than $35,000, for which the success attained will give full recompense.—*Syracuse (N. Y.) Journal.*

Meteorological Apparatus and Photographs.

The New England Meteorological Society proposes to have a loan exhibition of meteorological apparatus, photographs, etc., at the Institute of Technology, Boston, in connection with its fourteenth regular meeting in January, 1889. For this purpose the society invites contributions of articles to be sent to A. Lawrence Rotch, Physical Department, Massachusetts Institute of Technology, Boston, by prepaid mail or express, not later than January 12, 1889.