PROFESSOR MAREY'S INVESTIGATIONS ON THE ACTION OF THE HEART.

It is well known that the heart of an animal, after removal from the body, continues its pulsations for a time, longer or shorter in accordance as the animal was cold or warm blooded. In this manner, its muscular action, free from all mechanical effect, may be studied; and thus the cardiac muscle may be compared with others in the human economy. A simple way of experimenting is to place the heart of a frog or turtle in a small wax cup which contains it exactly, and to rest it on a tablet of metal. Above the heart, place a thin, light, wooden lever, articulated so as to have a free vertical motion, and terminating in a fine stylus which traces a line on a rotating cylinder. This apparatus is represented in Fig. 1, and is called the heart myograph. The lever, which is suitably connected with the ventricular portion, rises whenever the latter, contracting, swells as do the muscles of the arm when the forearm is vigorously bent. The point of the lever then describes an ascending line, more or less vertical according as the swelling of the muscle—that is, the systole of the ventricle—is more or less rapid. Then the lever descends as the systole ceases, when the cardiac muscle passes from the period of activity to that of repose. In this way, a curve is obtained whereby the movement of the heart muscle may be compared with that of any other muscle placed in identical or analogous conditions for exploration.

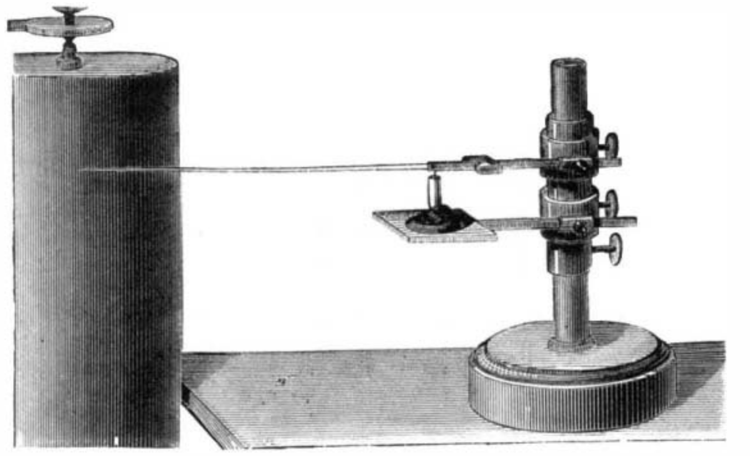

Fig. 1.—The Heart Myograph.

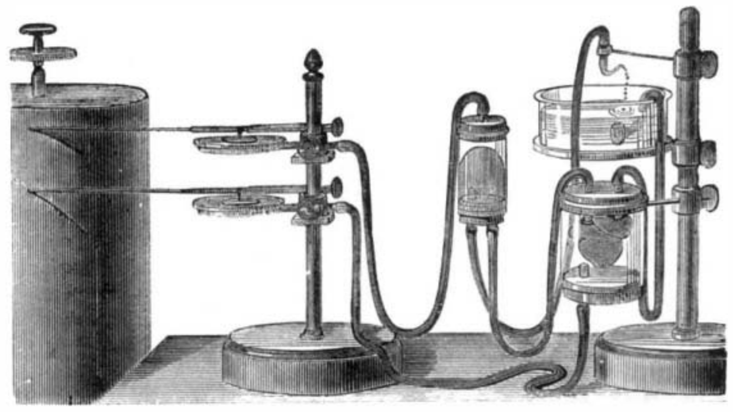

Fig. 2.—Apparatus for Studying the Changes in the Volume of the Heart, etc.

This comparison, when made, soon shows that each systole of the heart constitutes a simple act, which Professor Marey designates under the name of "shock" (*secousse*). The muscular shock is produced by the heart under the influence of a kind of simple discharge of the nervous apparatus which the heart contains in its sides, just as it is caused in any other muscle under the influence of excitation, similar in effect to the rupture of an electric current or the discharge of a Leyden jar. This simple action, which occurs at each beat of the heart, represents but one element of the more complex phenomenon observed in other muscles when they contract under, for example, the influence of the will. In this voluntary contraction, a series of shocks is produced which succeed each other so rapidly that practically a continuous action results. The same is observed when the nerve of a muscle is excited by rapidly interrupted currents; and it is evidently the more perfect as the interruptions of the exciting current are more frequent, or inversely. In the latter case dissociation takes place more easily, as the electric intermittences are the more separated. Now, by removing these excitations far enough apart, and conforming them, for example, to the rhythm of the heart: when a muscle is excited by electric currents, traces of independent shocks are obtained which are absolutely comparable, as Professor Marey has observed in the heart under the myograph. Consequently the systole of the heart is nothing more than a shock, an isolated element of the contraction, and not a true contraction. The complementary proofs of this theory are numerous. We cite one which is decisive: When the foot of a frog is removed and the nerve excited, the muscles contract. They furnish a simple shock when the excitation is single, and a series of shocks, more or less mingled (such as is termed tetanus) when the excitations are multiple. Now if, to the muscles in action, the nerve of a second foot, prepared in the same way, be applied, the remarkable phenomenon discovered by Matteuci, and by him called induced contraction, is observable. At each shock of the muscle excited, another shock is caused in the muscles of the other foot; at each tetanus of the first another is produced in the second; so that shock induces shock, and tetanus tetanus, and these truths may be considered to be laws.

It is now clear that, by substituting for the first foot a heart in action, the second foot will present either a shock or a tetanic contraction, according as the inducing heart gives either a shock or a tetanus.

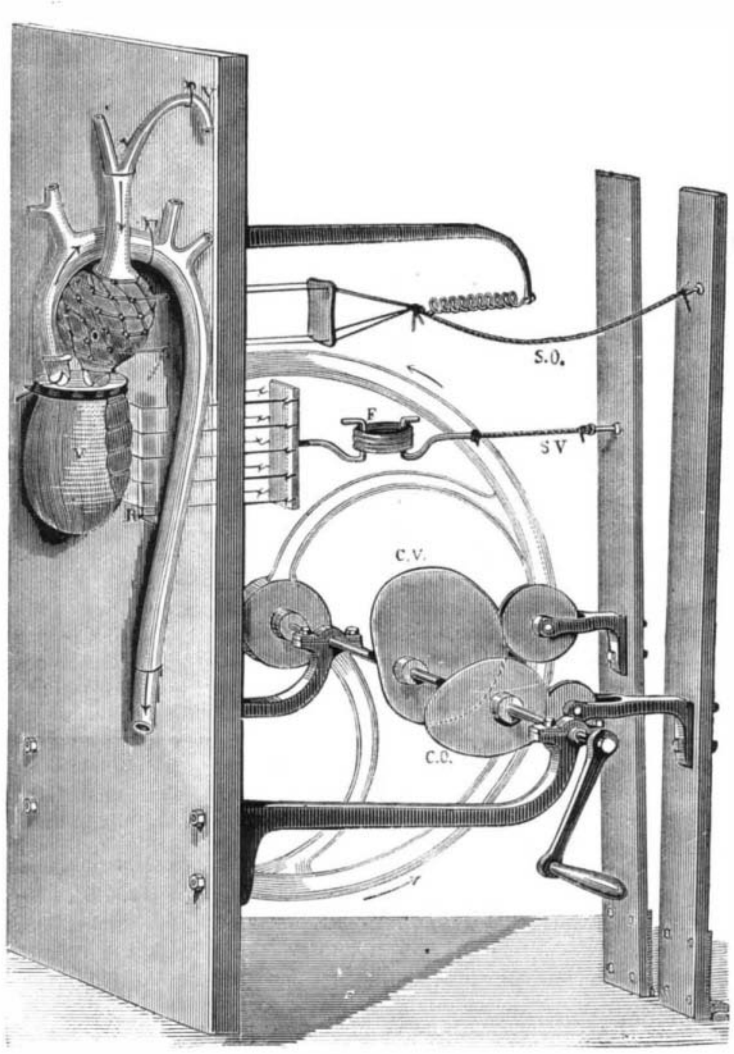

Fig. 3.—Schematic Apparatus for Demonstrating the Circulation of the Blood.

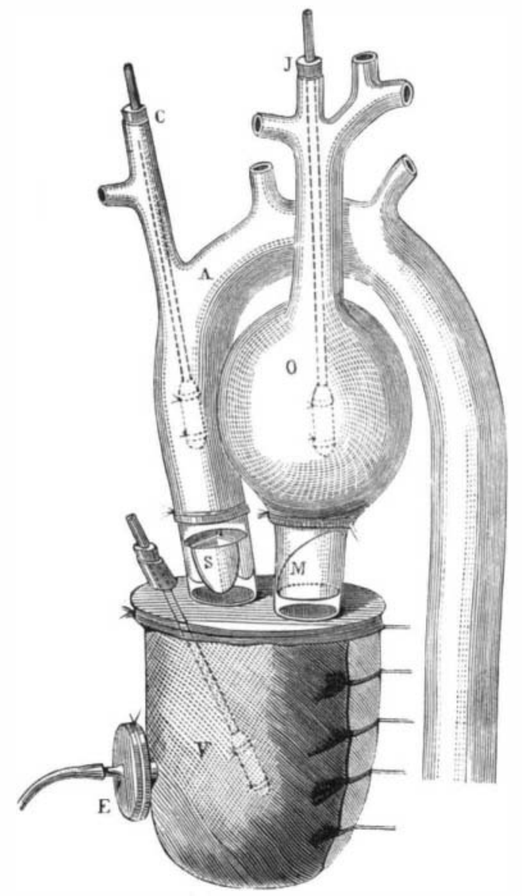

Fig. 5.—Arrangement of the Schematic Apparatus for obtaining Cardiographic Tracings.

Experiment shows that the induced foot gives a shock at each systole; and by virtue of the preceding law, it must follow that each systole is none other than a shock, and not a contraction. If we examine the effect produced by these systoles or shocks, we shall find that each of them drives from the heart and into the arteries the blood brought by the veins in the preceding diastole. It is important to discover whether work of the heart, that is to say, the quantity of blood thrown into the arterial system, increases proportionately to the number of systoles. For this investigation Professor Marey uses the heart of a turtle. He adapts one tube to the commencement of the arterial trunk, another to the opening of a vein, and shuts up all the other orifices, so that the organ is supplied with tubes leading to and away from it. Then he suspends the heart in a corked jar. The vein tube serves as a siphon to lead defibrinated beef blood into the heart, which thus maintains its motion, while the artery tube carries away the blood driven out. The arrangement of the apparatus is shown in Fig. 2. By dividing the volume of liquid carried through by the number of systoles which register themselves while the test tube is being filled, the average volume of each wave generated is obtained; and thus it is found that the quantity of blood pumped does not augment when the systoles increase in number. The same apparatus answers for determining the amount of mechanical work performed by the heart under various conditions. By connecting the interior of the jar in which the heart is placed with a suitable inscribing lever, Professor Marey is also enabled to take account of the changes in volume of the organ, which, as it swells or contracts, produces a compression or expansion of the air in its receptacle. By other apparatus, which need not here be described, the author obtains the curves of changes of arterial pressure with relation to the changes of the state of the heart. These changes of pressure constitute the pulse.

Having determined a comparison of the heart with other muscles, and examined its mechanical effects, Professor Marey next investigates how the phenomena noted manifest themselves by the cardiac pulsation. To this end he constructs what he calls the schematic apparatus of the circulation; it is represented in Fig. 3. The heart and artificial vessels are disposed on an upright plate as shown. O is the auricle receiving the liquid from the tube above, and V the ventricle, separated from the auricle by a valve, the latter opening when the ventricle dilates, and shutting when the same contracts, to prevent reflux. The ventricle opens into a large tube which represents the aorta. A number of small sigmoid valves are located at the junction, and prevent reflux from the aorta. To the elastic bag which represents the ventricle are attached a number of cords; these connect with a small plate. To the latter is secured a hook which, in turn, is connected to another hook, S V, by a number of rubber bands. The force of traction of the cords augments with the number of bands, and the elasticity of the latter imitate the elasticity of the muscular tissue.

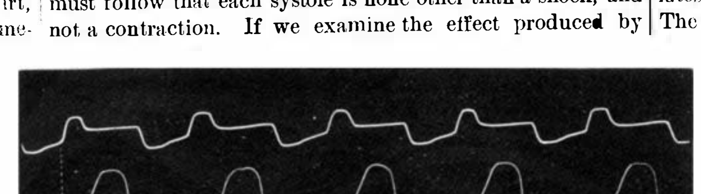

Fig. 4.—Tracings obtained by the Schematic Apparatus. O, pressure in the auricle; V, pressure in the ventricle; A, pressure in the aorta; P, beating of the heart.

The auricle, O, is surrounded by a silk net, to which four cords are attached, communicating with a small rectangular piece of wood, and then unite in one, being kept taut by a horizontal spiral spring. The vertical levers on the right connect with the cords, S V and S O. Now, these levers are oscillated by the cam mechanism shown, and they therefore produce movements of the auricle and ventricle similar to those of the natural heart. This is done by proportioning the cams according to the data previously obtained regarding the muscular action of the heart from the myograph. By applying, to the apparatus just described, proper indicating devices, it was found that it produced a tracing identical with that of the human heart.

In Fig. 4, we give the tracings obtained by the pressure of the ventricle, V, the auricle, O, the aorta, A, and the pulsation, P, of the artificial heart.

In Fig. 5, we represent the arrangement of the schematic apparatus used for obtaining the tracings.

The results of Professor Marcy's investigations are that we are now enabled to interpret with accuracy a host of details presented by the tracings of the human heart. He has imitated, on the artificial circulation, the lesions to which organic affections of the heart are due, and reproduced both the abnormal sounds of the heart beat and the principal types of traces furnished by actual patients.

Communications.

Extinguishing Fire.

To the Editor of the Scientific American:

In your issue of December 30, you recommend discharging water through perforated pipes in the form of spray for extinguishing fire. If water in the form of spray be a good extinguisher, as it undoubtedly is, as numbers of proofs exist in our factories and picker rooms, why do not our fire departments use it in that form in all cases where they can? Leaving the firemen to answer that question, I will proceed to adduce a few facts in support of the theory that a spray is the true method of applying water wherever the burning object can be reached by it.

Water operates, in extinguishing fire, by absorbing the heat and reducing the temperature of the burning substance so low that fire cannot exist; and as the amount of heat that water will absorb depends on the amount of surface of water in contact with the fire, the more surface we can cover with a given amount of water, the better. As flame is the principal propagator of fire, to arrest it is the first thing to do; and as it is more than three thousand times lighter than water, and in most cases a mere shell or curtain, a fraction of an inch thick, the extreme absurdity of trying to subdue it with solid streams of water will be apparent. If a man in the character of a sportsman were to fire an inch ball into a flock of humming birds, with the intention of killing as many as possible, he would be regarded as a fool; but if he were to melt the inch ball up, and cast it into shot one-thirtieth of an inch in diameter, he would have twenty-seven thousand such shot, and their aggregate surface would be thirty times greater than the inch ball. If he were to load his gun with this shot, and fire into the flock, at proper distance, the slaughter of the little beauties would be terrible; and if a fireman would divide up his stream into spray, so that he could cover thirty times more flame, he might expect a corresponding result. The globules of water would be so small that a large portion of them would be heated through and converted into steam; and as steam contains five times more heat (latent) than boiling water, we gain a great advantage in this. Steam is also an excellent extinguisher, and this is an additional advantage. As a large portion of the water is converted into steam when applied in the form of spray, a small amount serves, and the damage by water is very small.

If the two first engines that reached the burning Brooklyn theater could throw five hundred gallons of water each per minute, and divide every cubic inch of water into sixty thousand drops, in two minutes the smoke and heat would have been sufficiently subdued to have enabled outsiders to enter and rescue the unfortunate inmates. I am well aware that this statement may seem extremely absurd to firemen, who have never experimented in this line; but before they condemn it, let them take out a couple of engines and try the experiment. The barbarous system now in use, that so frequently desolates portions of our cities, fills our houses with mourning and our cemeteries with new-made graves, must give way to the dictates of Science. Humanity demands it, and I call on the scientists and chemists throughout the land to aid in introducing this needed reform.

Little Falls, N. Y. CHARLES OYSTON.

Sir Titus Salt and Saltaire.

The example of one such man as Sir Titus Salt, the great manufacturer and inventor who recently died in England, is worth more, as a means of pointing out wherein a just and equitable solution of the labor problem lies, than all the results of the strikes and lockouts that ever agitated the industrial world. He has shown us how the inexorable laws of demand and supply may be covered with a broad mantle of charity and philanthropy; how a great and complex business may be conducted to the mutual benefit of employer and employed without involving other than those simple relations, free from entangling co-operative or profit-sharing alliances; and above all, he has unmistakably proved that the employer in no wise serves his own interests better than in promoting the welfare of those dependent upon him. Many men have died and left monuments of liberality wherein their wealth has nobly been devoted to the public good; but as a rule, such dispositions have been the means chosen of investing riches already acquired in pursuits not necessarily connected with the object of the outlay. Few men have, like Sir Titus Salt, combined their business with their philanthropic enterprises, and thus while benefiting themselves have doubly benefited society by their wise munificence.

Titus Salt was the son of a Yorkshire wool stapler. In early life he became a farmer, but subsequently entered into partnership with his father, and as the business extended started alone as a wool spinner. At this time immense quantities of alpaca wool were stored in Liverpool, finding no purchasers because no one knew how to utilize it. It occurred to Salt that it would spin out good yarn. He privately tested it, produced an excellent fabric and at once bought up all of the material that he could find. This was the first manufacture of alpaca, and likewise the basis of Salt's colossal fortune. For twenty years he labored on as a wool spinner, always thrifty and industrious, until, having completed his fiftieth year, he concluded to retire upon the competency he had amassed. But the necessity of providing for his five sons and the desire to carry out the philanthropic plans which he had long meditated induced him to change his mind. The locality where he was located was already overcrowded, and hence he determined upon the gigantic scheme of founding a new town—a working man's Arcadia.

Accordingly he purchased a large plot in the beautiful valley of the Aire, contiguous to a railway and a canal, and thus well provided with shipment facilities. Here he erected buildings covering six and a half acres, including roomy factories and abundant dwellings for the work people. On the opening day of the village of Saltaire, says Smiles, three thousand five hundred people dined in the combing shed; and the founder then said "that nothing is to be spared to render the dwellings of the operatives a pattern to the country: and if my life is spared by Divine Providence, I hope to see satisfaction, contentment, and happiness around me."

This was no empty wish, as circumstances soon proved. A church was added, then a literary and philosophical institution. Large schools for children of all ages were erected; cricket grounds, croquet lawns, and abundant pleasure grounds were provided; and a large dining hall, baths and wash houses, a dispensary, and almshouses for pensioners were built. For the accommodation of the three thousand workmen, seven hundred and fifty-six houses were constructed of stone and brick. Each has gas and water supply and separate enclosures. The rents vary from 58 cents to $1.80 per week.

Besides taking part in musical performances—for which even the necessary instructors are provided by the firm—a large number of the skilled workmen (we quote from Mr. Smiles' "Thrift") "devote their leisure hours to various scientific amusements, such as natural history, taxidermy, the making of philosophical instruments, such as air pumps, models of working machinery, steam engines, and articles of domestic comfort, while some have even manufactured organs and other musical instruments." There is no drinking house in Saltaire; so that the vices and diseases associated with drunkenness, as well as those peculiar to poverty, are unknown. Every sanitary measure—drainage, cleansing, and ventilation—is attended to. The work people are also thrifty. They invest their savings in banks provided for them and in lucrative ventures. "With every convenience and necessity as well as every proper pleasure provided for them; with comfortable homes and every inducement to stay at home; with fishing clubs, boating clubs, and cricket clubs; with school rooms, literary institutions, lecture hall, museum, class rooms, and churches established in their midst, there is no wonder that Saltaire has obtained a name, and that Sir Titus Salt will be remembered as one of the wisest of popular benefactors."

Color Ghosts.

Some years ago a book was published in this country—we cannot recall its exact title—the purpose of which was the production of ghosts. On its pages were various representations of spectral shapes, printed in extremely brilliant colors on a white ground. Directions were given to fix the eyes intently on these for some moments, and then turn them suddenly to a white wall or screen, when the "ghost" would appear in the form depicted in the book, but of an entirely different color. If the picture was red, the specter on the wall would be green; if the former was yellow, the latter would be blue; and so on.

A similar illusion may be produced by any of our readers in a much simpler way. Cut a small disk out of white paper and lay it on a black surface. Look at it steadily for a quarter of a minute or so, and then direct the eye to a white, or, better, to a gray surface, as a sheet of gray paper; and you will see a dark image of the shape and size of the white disk. If a colored disk is used, the after-image, as it is called, will be colored, but of the hue complementary to that of the disk; that is, if the one is green the other will be purple, if the one is yellow or orange the other will be of a darker or lighter blue, etc. Complementary colors, as most of our readers probably know, are those which, if mixed, will produce white.

If the surface is of the same color as the disk, the after-image will be faint and whitish; if it is of the color complementary to that of the disk, the image will appear of the same color intensified. Thus, if the disk is bluish green, and the gaze is turned from it to a red ground, we shall see a "ghost" of a deeper and more brilliant red. If we look upon a colored surface of any other than the complementary hue, the color of the after-image will blend with that of the surface. For instance, if the object is green and the surface blue, the image will be violet.

These phenomena admit of a very simple explanation. When the retina of the eye has been exposed to a continued impression of one color, it is wearied and becomes less sensitive to that color. If now it is exposed to the impression of white light, it will respond more readily to the other colors that make up white, that is, to those which produce the complementary hue. Quite likely some of our readers who have occasion to use red ink have observed that if, after writing with it for some minutes, they change directly to black ink, the latter will at first appear of a distinct green color. Some eyes are more sensitive than others to these delusive impressions, but any person can see the complementary color if he has looked at the other long enough to tire the eye.

Dr. Bezold, in his "Theory of Colors," among many curious things connected with this subject, illustrates the fact that, while if a black object be seen against a colored ground (as black print on red paper), the black, when viewed intently, will show a slight tinge of the complementary color, the effect is greatly heightened by laying thin white tissue paper over the surface; showing that "an admixture of white light is favorable to the production of contrast." He also notes the singular fact that the various colors which may be given to the ground differ greatly in their capability of calling forth the contrasting colors. "Green, blue, and violet—in fact, all the so-called cold colors—will originate very vivid contrasting colors, while this is the case to a much lower degree with red, yellow, and yellowish green." The colored plates in Dr. Bezold's book illustrate this very vividly, but the reader can produce a similar effect by putting a disk or figure cut out of black paper or cloth on a bright colored surface—red, yellow, green, blue, or purple—and spreading the white tissue paper over the whole. The variety of hues which the black assumes is very striking, and tends decidedly to shake one's faith in the popular proverb that "seeing is believing." We know that the black is black, but we cannot see it as black, however earnestly we may endeavor to reason ourselves out of the illusion.—*Boston Journal of Chemistry.*

An English Editor on American Railways.

Mr. Walter, of the London *Times*, has been interviewed by a New York paper. The report says: "Mr. Walter did not feel himself competent to judge of the comfort of ordinary American railway travelling. He had ridden so luxuriously in the special Pullman car which had been placed at his disposal that he was unable to form an idea of the way in which other people travelled. 'The palace car,' he exclaimed enthusiastically, 'is fit for the Queen to ride in! In fact, it is much handsomer than the one she uses.' The liberality with which railroad directors carried him to and fro over the land was a cause of great astonishment to Mr. Walter. It was a courtesy entirely unknown in England. The Queen herself was obliged to pay immense sums every year for railway conveyance, and no railroad company in all England would think of offering a coach for the free use of any gentleman, public or private. The American car, in Mr. Walter's estimation, was far superior to the English carriage. The possibility of being shut in with thieves or madmen (it had fallen to his own lot to be shut in with a madman); the close, cramped quarters which, in their very nature, stifled all the comfort out of the unhappy traveller; the partitioning a man from the sight and society of his fellow-creatures; and, above all, the shortness of the carriages, which caused them to sway and jerk about so violently that conversation became a torture and reading an impossibility—all these things combine to render a journey in an English railway carriage a matter of something worse than unpleasantness. The 'permanent way,' or road bed, of the English railroad was much more substantial than that of the American; but the English carriages could not be compared with the American cars."

Gold Mining in China.

Mr. Adkins, the British Consul at Newchwang, gives an account of the valley of Chia T'i Kou, some 30 miles long, in which there are rich diggings about five or six days' journey east by south from Kirin and Newchwang. The veins of quartz in the hill sides are very numerous. The quartz, when dug, is roasted, then crushed, and then washed on a cradle or "slip;" and so rude and imperfect is the operation that it usually pays to wash the quartz two or three times. The quantity of gold found in a ton of quartz varies; but a Chinese miner, who showed the Consul a slab of quartz brought from these diggings, assured him that less than $230 worth of gold per ton is considered a poor yield. The miners in this locality are said to be a lawless set, and to have a very peculiar social organization. A man named Han pays an annual tribute of 20,000 thaels to the Chinese Government and governs absolutely within the limits of his concession, and no official writ runs there without his permission. He has an armed following, and a number of miners and workmen in his pay. Those who are not in his employ pay a royalty for permission to mine. The community under his rule is said to number about a thousand, and is principally Chinese, but a number of Coreans have recently found their way into the territory and are working with considerable success.

A Magazine Gun Invented in 1775.

A writer in *La Nature* states that in 1775, one Charriére, a gunmaker of Paris, devised a musket capable of being discharged "ten times in a minute." The description is preserved in the archives of the French Navy, whence it appears that after trials the gun was rejected as dangerous. The cartridges were all placed in the single bore and separated by movable partitions so that but one could explode at a time.