THE

AMERICAN FIRE-ALARM TELEGRAPH:

A LECTURE

DELIVERED BEFORE THE SMITHSONIAN INSTITUTION,

MARCH, 1855.

By WILLIAM F. CHANNING, M. D.

Reprinted from the Annual Report of the Smithsonian Institution.

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There are few positions more imposing than to stand at the Capital of a country like our own, made up of confederated States, each State made up of confederated counties, each county, perhaps, made up of confederated townships; every part, from the least to the greatest, conspiring to form an organized whole — one nation, one people. From such a Centre it is natural to look abroad over the fair land, at territories and commonwealths, at cities and hamlets, whose interests and national life are thus interwoven into one, and to ask what are the laws and what the means of organization by which Civilization attains these her great ends? It is natural, from such a point of view, to inquire into the general laws of relation by which parts are intelligently bound together to form a composite whole for some end of use or beauty, that is, the laws of relation by which every organization, every mechanism, in the high sense of that word, is formed. The material universe, with its majestic movements of suns, stars, planets, light, heat, winds, tides, seasons, is thus a mechanism, actuated ever by the infinite Power, shaped and guided

by the infinite Wisdom, animated by the infinite Love. The power which went forth at creation established the universe, with all its beauty and capacity, by the intelligent combination of outward parts. By the marriage of elementary atoms, by the joining of lesser unities to form greater, in accordance with a principle of absolute order and harmony, nature took her perfect form. With this type of creation ever before us, the manifestation of God in his works, let not the word mechanism, if it effects only the humblest organization of material elements, appear to us low or unworthy. Whoever, in practical science, attains a result of human use, by the intelligent combination of outward parts, emulates, in his degree, the creative wisdom, which, in the language of an apocryphal writer, hath made all things by number, measure, and weight.

In the organization of states and municipalities, the object or end in view, the formative principle, is some ideal of human life and society, some thought or aspiration for freedom, justice, brotherhood; but the embodiment of these is an outward frame-work of Civilization, the highest mechanism to which human thought and human hands have ever been applied, requiring the perfect relation of parts, and methods of communication and intercourse arranged and governed by an absolute law of order. It is here that Science becomes the great instrument of Civilization.

In the early history of this country, the thirteen colonies stretched along the sea-coast, and commerce joined their interests and established a common circulation between them. The sailing vessel — the clipper-schooner — then measured the possible rate of intercourse and capacity of co-operation between those States. A languid life existed; a weak Con-

federacy in the outset was formed, proportioned to their outward means of communication and organization. A few centuries earlier than this, before navigation and other arts of locomotion had made much progress, each settlement on the coast would have been the centre of a small jurisdiction, with still less power of co-operation or union with its neighbors; science would have slept; events would have been slow; the human mind, for the most part, stagnant; civilization in abeyance; man isolated in industry and social sympathy from his fellow man.

At the time of the formation of the American Constitution our fathers looked with anxiety at what seemed to them an immense territory, though now but a small fraction of this republic, and asked if veins and arteries could ever ramify through this body politic, and interfuse the whole system with a common life-blood. To increase the difficulty and danger, new territory was added, new States in the interior of the country came in; but, at the same time, the genius of civilization and the providence of God gave to us the realization of the dream of the poet in the invention of the steamboat. A new means of relating men to each other, of combining their industry, of introducing the era of peace and good will upon earth, was discovered. Wherever the great rivers penetrated the heart of the continent, there quick communication could be had with the centres of government, industry, and commerce, throughout the land.

A few years later, and our population, with the instinct of freedom, spread still further over the prairies and into the wilderness. The nation was again outgrowing its means of intercommunication and common life, when the railroad and steam-car were invented, and again the continuance of the

commonwealth became possible; the confederated republic had a new lease of life by virtue of the application of Science to Civilization.

Still later, our empire spread to the Pacific, and stretched three thousand miles across the American continent. Different oceans washed its two shores. Our faces on the Atlantic coast were turned eastward, our brothers on the Pacific looked westward, and the Rocky mountains rose between. By steamboat or railroad, weeks must now intervene in the communication between distant parts of this mighty organization of confederated municipalities and States. The veins and arteries were provided, but the living nation had yet no nervous system to flash communication from one part to another, and to combine the whole into an organized body, which might, in its capacity for future expansion, include the whole race, and inhabit the whole earth. Before this time of need had fully arrived, the electric telegraph received its most important development, and was introduced into America.

The electric telegraph is thus the nervous system of this nation and of modern society by no figure of speech, by no distant analogy. Its wires spread like nerves over the surface of the land, interlinking distant parts, and making possible a perpetually higher co-operation among men, and higher social forms than have hitherto existed. By means of its life-like functions the social body becomes a living whole, and each of its new applications marks a step in the organization of human life.

We are thus conducted to the result of the highest philosophy: that society, in its form of organization, is human, and that it presents in its progressive development continually higher analogies with the laws of individual being. In pass-

ing from these general principles to scientific detail, in the illustration of the municipal fire-telegraph, we shall find some of these analogies presenting themselves in still more definite and striking forms, thereby setting their seal of confirmation on the natural arrangement of the system of telegraphic organization, which is the special subject of the lecture this evening.

Soon after the first introduction of the electric telegraph into this country, I conceived the idea of the municipal telegraph, as distinguished from the common form of telegraph connecting distant places. The telegraph, as you know, usually consists of a galvanic battery or generator of electricity in one city or town, and insulated wires or electrical conductors going out thence and proceeding to a register or telegraphic instrument in another city or town, which instrument indicates every electrical wave or impulse that is sent over the wires from the distant extremity of the line. This requires that there shall always be what is called a "circuit" of electrical conductors — that is, that the electric current shall have the opportunity of going out from one pole of the battery through one conductor to the distant register, and returning through another conductor to the other pole of the battery. When this "circuit" is completed, an electrical wave or current immediately begins to pass through the conductors, though they may be hundreds of miles in length; and when the "circuit" is broken anywhere, it ceases to pass. All telegraphic signalizing is thus effected by alternately completing and breaking the circuit at suitable intervals.

The municipal telegraph, while it employs the same essential conditions, adopts a very different arrangement. Its function is not to connect distant towns or independent centres of

life and activity with each other, but it is to organize a single city or town so as to bring every subordinate part into relation with its centre of government and direction. Its purpose is to multiply points of communication, to cover the surface of the municipal body as thickly, if you please, with telegraphic signalizing points as the surface of the human body is covered with nervous extremities or papillæ, the whole being intelligently connected into a system by which the municipal body shall understand itself in every part, and shall have a common life and vital functions for its own essential purposes.

The common telegraph is *linear*—it is a "line" of telegraph. The municipal telegraph is the application of the telegraph to a *surface*, making it cover a space with telegraphic nerves and papillæ as thickly as required, to furnish a complete organization. The common telegraph connects *distant* points, as its very name implies, the more distant the better to illustrate its character. The municipal telegraph contemplates the linking together of a multitude of *near* points, the nearer the better to illustrate the peculiarity of the system. The common telegraph connects two independent centres of life and activity. The municipal telegraph connects a multitude of subordinate points with one centre, and makes the position of those points dependent upon the centre and the needs of the system.

The occurrence of a fire in a city is one of the exigencies in which rapid and intelligent co-operation is necessary between the members of the municipal body. As our warehouses, manufactories, and public buildings are constructed, the extent of a conflagration depends, to a great extent, upon whether it is reached by the fire department within a short time or not. The first ten minutes in directing the alarm is

worth hours afterwards. In organizing a system of fire-alarms, it becomes, therefore, necessary that every locality in a city shall have the means in its immediate neighborhood of notifying the existence of a fire. In order that this may be done systematically, and under organic direction, it is necessary that this notification should be sent, in the first instance, to a common Centre, which will naturally be at the City Hall; and it is further necessary that the means should exist of giving thence an *instantaneous*, *definite*, and *public* alarm of fire.

The first requisite for a fire telegraph is certainly in its means of communication. What, then, are the safeguards of the municipal telegraph by which its indications may be made always reliable, and by which interruption, by accident or design, may be rendered improbable or impossible? These are the use of strong, well-insulated wires, carried over the houses and attached to lofty and well-selected buildings; the use of duplicate wires, following different routes between all the stations, so that if one wire is broken from any cause, another and distant wire may still continue the circuit; and the dispensing entirely with the use of the ground as any part of the circuit, as used in common telegraph lines. Instead, also, of using in a municipal telegraph one great circuit which should traverse a whole city, a number of lesser circuits may be used, radiating from the centre, like the petals of a flower; so that if one circuit should be interrupted, all the others would still be intact and operative. These safeguards prove sufficient in practice to make the municipal telegraph the most certain means of communication which has yet been devised, under all conditions of weather and season.

In June, 1845, nearly ten years ago, I first published a notice of the fire-alarm telegraph, involving, essentially, the principles and safeguards upon which it has since been constructed. No definite action was taken upon it until 1848, when the subject was brought before the city government of Boston by the mayor, and two machines for striking the city bells from a distance, by means of the telegraph, were constructed under direction of Moses G. Farmer, Esq., one of the ablest and most ingenious telegraphic engineers in the country.* One of these machines was placed in the belfry of the Boston City Hall and connected with the line of telegraph extending to New York. Under these circumstances the operator in New York, by tapping on his finger-key, struck the bell on the City Hall a number of times, and, according to the newspapers of that day, thus originated a false alarm of fire in Boston. This was the first illustration of the capacities of the fire-alarm telegraph.

The matter slept, however, till 1851, when I brought the system formally, and with specific plans, before the city government of Boston, and urged their action as due to science and to the public interest. This city government, unlike many others, induced only by the statement of scientific truth, voted ten thousand dollars to test a system wholly untried, and without precedent in the world. The mechanism and construction were placed in the hands of Moses G. Farmer, Esq., and, in 1852, were brought by him into thorough and successful operation. The American fire-alarm telegraph, in

* These original machines were exhibited, with other apparatus, in delivering this lecture; but, for the sake of connection, reference to the experimental illustrations will be excluded from this written report.

its development as a practical system of organization, tested now for nearly three years, should thus always be ascribed to Mr. Farmer equally with myself.

It has been stated that the conditions of the fire-alarm telegraph require that information should, in the first place, come in from any part of the circumference or surface of a city to its centre, and that thence an alarm should go out in a definite form to the public. The organization of a city under the system is as follows: —

From the central station, at the City Hall, go out wires over the house-tops, visiting every part of the city and returning again. These are the *signal circuits*, by which the existence of a fire is signalized from any part of the surface of the city to the centre. Strung on these circuits, or connected with them, are numerous *signal boxes*, or signalizing points, of which there may be one at the corner of every square. These are cast-iron, cottage-shaped boxes, attached to the sides of the houses, communicating, by means of wires enclosed in a wrought-iron gas-pipe, with the signal circuit overhead. On the door of each signal box, the number of the fire district, and also the number of the box or station itself, in its district, are marked; and the place in the neighborhood where the key-holder may be found is also prominently notified. On opening the door of the signal box a crank is seen. When this is turned it communicates to the centre the number of the fire district and of the box, and nothing else. Repeated turns give a repetition of the same signal. By this means any child or ignorant person who can turn a coffee-mill can signalize an alarm from his own neighborhood with unerring certainty.

Connected with the signal circuits at the central office, where they all converge, are a little alarm-bell and a register, which notifies and records the alarm received from the signal box. The galvanic battery which supplies all the signal circuits is also placed at the central station. If a fire occurs near signal box or station 5, in district 3, and the crank of that box is turned, the watchman or operator at the central station will immediately be notified by the little bell, and will read at once on his register the telegraphic characters which signify district 3, station 5. The characters used in the fire telegraph are a group of dots to indicate the district number, — as three dots for district 3, and a group of dots and lines to indicate, by arbitrary characters, the station number. Thus a line and two dots may indicate station 5. These alternate on the record, and are repeated as often as the crank is turned.

The register used at the central station is generally the Morse register; which I recommend, in connection with the system, as being most in harmony with its principle of operation.

We have traced the alarm of fire from a signal box into the central station. How shall the alarm be given from that centre to the public? From the central station proceed also several circuits of wires, called alarm circuits, which go to the various fire-bells throughout the city, and which are connected with striking machines similar in character to the striking machinery of a clock, but *liberated by telegraph.* The operator at the central station is enabled, by the mere touch of his finger upon a key, to throw all the striking machines into simultaneous action, and thus give instantaneous public alarm.

By what precise mechanism is this effected at the alarm-bell stations? The heavy hammers may be raised above the bells by any force which can be conveniently applied, as by a weight which may be wound up by hand. But in all cities where the water is confined under pressure in the mains, it will supply, by means of the eccentric water engine, known familiarly under the name of the "water meter," the power necessary to wield the heavy hammers with the greatest facility. But how are hammers of one or two hundred pounds weight to be tripped by telegraph? To effect this readily, Mr. Farmer invented his electro-magnetic escapement, one of the most beautiful and original of recent mechanical applications. In this escapement the electro-magnet, when it becomes charged by the galvanic influence received from the central station, attracts the little piece of soft iron or armature in front of it, which supports a small lever poised nearly vertically, and weighted with a little ball at its upper end. This lever and ball, when tripped by the withdrawal of the armature, acquires sufficient momentum to strike up the *detent* of the train of wheels which, in their revolution, raise the hammer and then allow it to fall. A single blow of the hammer follows each electrical impulse sent from the central station, and the revolution of the train of wheels raises also the falling lever into its place and catches it again on the armature lever, ready to be disengaged or tripped for another blow.

At the central station, connected with the alarm circuit, is a galvanic battery and an instrument for completing the circuit of that battery, called the district keyboard. This is constructed with several keys, corresponding to the numbers of the fire districts in the city. If you depress any of these the machinery inside commences to move, and the circuit is

completed at such intervals as to strike and repeat on the distant alarm bells the district number represented by that key with suitable pauses between.

We supposed that the operator at the central station received the signal of fire from district 3, station 5. He now places his finger on the key of district 3, in the keyboard. Instantly all the alarm bells in the city begin to strike synchronously the district number *three*, and continue, no matter what their number or what the weight of their hammers, so long as that single finger rests on that key.

But the operator has a finger key before him connected with the signal circuits, by which he can answer back and strike a little electro-magnet, armature, and bell, enclosed in each signal box. He has received a signal of fire from district 3, station 5. While his hand rests on the key of district 3 he taps occasionally *five* times on the return key of the signal circuits, which I have just described. The little bell in each signal box, at the corner of every square, strikes *five*. The fireman listens to the public alarm bells and gets from them the number of the district; he runs by the nearest signal box and listens a moment to gather the station number from its little signal bell, and he now knows that the fire is at district 3, station 5. He directs his own motions and his engine, from the start, to within, perhaps, one hundred yards of the fire.

No other system has ever attempted to localize a fire more precisely than by the district number; and in some cities, like New York, the districts may be two miles long.

In all previous systems there has been a delay, first in getting an alarm from the fire to the bells; and, second, in finding the place of the fire in the district after the alarm was

given, and reaching it by the shortest route. By the fire telegraph both district and station are publicly notified; the one by the alarm bells, the other by the signal boxes.

Let us now consider for a moment the analogy between the municipal organization thus described and the nervous organization of the individual. A coal of fire falls upon my hand; one of the nervous extremities, or papillæ, the "signal box" of the part, sends instantly its own special signal, by means of a nerve of sensation or signal wire to the brain, where the existence and locality of the lesion is at once recognized. An act of intelligence and volition ensues. The watchman of the central station, or brain, does his part. An impulse to motion is sent out over the proper motor nerves, or alarm wires, and muscles are called into play in a suitable manner to remove the cause of injury, just as the electro-magnetic muscles and iron limbs in the bell towers are thrown into suitable and related action to the original cause and place of alarm.

The telegraph, in its common form, communicating intelligence between distant places, performs the function of the *sensitive* nerves of the human body. In the fire telegraph it is made to act for the first time in its *motor* function, or to produce effects of power at a distance; and this is also connected with the sensitive function, through a brain or central station, which is the reservoir of electric or nervous power for the whole system. We have thus an "excito-motory" system, in which the intelligence and volition of the operator at the central station come in to connect sensitive and motor functions, as they would in the case of the individual.

The conditions of municipal organization absolutely compelled the relation of circuits which has been described. The

analogy with the laws of individual life was not perceived until after the system was evolved, and it came then as a confirmation of the correspondence of the system to natural law, and of the necessity of the arrangement as a means of order.

I should not be precluded from saying in this place, what historic truth at this time requires, that the development of the "motor function" of electricity, or of the means by which electro-magnetic power can be exerted at a distance, is due to the early experiments of the Secretary of this Institution, Professor Henry, whose discoveries in electro-magnetism and especially of the quantity and intensity of the magnet in 1830, laid the foundation for all subsequent forms of the electro-magnetic telegraph, and made subsequent steps comparatively easy. In the publication of these experiments, the induction of the electric telegraph as thenceforth possible was distinctly made by him; and at a period not much later, weights were released and bells rung by him at a distance by electric influence transmitted through long conductors.

In Boston, where the fire-alarm telegraph has been in successful operation for nearly three years, a star of wires is seen radiating from the top of the City Building. These are the signal circuits connecting into one system forty-six signal boxes scattered over the city, and the alarm circuits connecting twenty-four belfries on church, school, and engine houses. A few large bells would be preferable to this multiplicity of smaller ones, but this whole number are struck by the touch of a single man's finger in the central station. For the sake of economy in battery power, the district keyboard is so arranged as to throw the battery on the four alarm circuits separately, but in rapid succession at each blow. Practically,

the bells strike together, or as much so as is desirable. At night, sometimes out of the profoundest stillness, the district number will suddenly strike upon the ear in a chime of perhaps eight or ten bells, their sound coming in one after the other in proportion to their distance from the ear, but always in an invariable succession at each blow. Then the alarm ceases and the whole city is as suddenly silent.

The operator at the central station is sometimes able to throw the bells on, and tap back to the signal boxes before the originator of the alarm has ceased to turn his crank in the immediate neighborhood of the fire. As soon as the bells strike, groups of persons will be seen clustering around each signal box to listen to the tapping of the station number, and it is soon known to the whole fire department exactly where the alarm originated.

The battery employed on the Boston signal circuits is Farmer's protected Grove's battery, which keeps in action several weeks or even months without being replenished. Instead of a galvanic battery on the alarm circuits, a large magneto-electric machine has been recently substituted, which is driven by a water meter, and which furnishes the electric current by which the bells are rung.

The heaviest hammer in the system at Boston weighs one hundred pounds, and it is wielded by the Cochituate water at an expense of only one gallon for each blow, and tripped by telegraph from a distance of two miles. By virtue of the electric current and the pent up water, this bell, and others associated with it, might be rung in measured strokes from the beginning to the end of the year by the pressure of a single man's finger in a distant room.

All of the stations in Boston are provided with "lightning catchers," or ground conductors for atmospheric or induced electricity. Hence an incidental protection from lightning, commensurate with the extent of the network of wires above, is obtained for the city. When these ground conductors have been temporarily removed from the alarm-bell stations, a flash of lightning has been occasionally followed by a single blow from one or more of the bells. But where the lightning catchers have been in place, they have proved sufficient, except in rare instances, to divert atmospheric or induced currents from the electro-magnets to the ground. No practical or serious inconvenience has resulted from this source. But it has occasionally been a matter of curiosity and interest to hear the lightning thus tolling the alarm bell.

The total loss by fire under the telegraph fire-alarm system, according to the accurate "Report of the Boston Fire Department for the year 1854," was only $150,772, or less than one dollar for every inhabitant; a loss which, for its small amount in so compact and wealthy a city, cannot be paralleled in America.

Out of one hundred and ninety-five alarms of fire in Boston in 1854, *twelve* are recorded as false; but at least *six* of these were from supposed fires, leaving only *six* unaccounted for. The whole number of alarms and the proportion of false alarms have been greatly diminished by the system. Science can make no contribution to Civilization without the requisite social conditions. The trust of the fire telegraph system, in this case, was placed in the hands of the citizens, and it has yielded to them its full fruits without abuse. This may deserve perhaps to be chronicled as an instance of well-rewarded

confidence in the sobriety and capacity for self-government of the American people. The signal box, which is the sensitive extremity of the system, may be protected by various methods, according to social requirements. In Boston, it has been guarded best by putting it in the most public place and exposing it to the fullest light.

The fire-alarm telegraph contains also the elements of a perfect police system. In addition to the crank for alarm, every signal box is provided with a finger key, by means of which, communications in the ordinary telegraphic method can be sent to the central station, and an answer can be returned from the centre and read by sound from the little bell in the signal box.

The mechanism of the fire telegraph is arranged and disposed for the purpose of preserving wealth, the fruit of human industry and nature's bounty, from destruction. It therefore accomplishes an end of human use. But more than this, it is a higher system of municipal organization than any which has heretofore been proposed or adopted. In it the New World has taken a step in the forms of Civilization in advance of the Old.

Channing...