the road, both connecting with one general office in New York. In conjunction with the American Telegraph Company, they have recently laid a cable from New York City to Jersey City, which is in successful operation.

Both of the wires are kept almost constantly busy, — most of the time in transmitting messages for the road, although the line is now open to the public, and the revenue derived from paid messages amounts to about $ 15,000 per year. The expense of operating the line is about $ 36,000 per annum.

The length of each wire (upon the main line) is four hundred and sixty-nine miles. Beside this they have the Piermont and Newburg branches, making altogether over one thousand miles of line.

One of their wires is divided into sections to correspond with the division of the road; the business of each division being transacted separately from the others. The other they work in one circuit between New York and Dunkirk, four hundred and sixty-nine miles.

They employ about one hundred operators, seven repairers, twelve messenger-boys, and sixty-eight offices, — seventeen of which are kept open constantly, both day and night.

They use the Morse apparatus; — in the main circuit the Grove battery, and for locals Daniell's improved zinc and copper.

In concluding this description of the use of the telegraph upon one of the best-managed roads in this country, we will say, what strict justice requires, that to Charles Minot, Esq. is due the credit of its conception and completion, in the face of great opposition on the part of other officers of the road, the accomplishment of which has been of inestimable benefit to both the railroad and the public generally.

THE ELECTRIC FIRE-ALARM.

Among the most important uses of the Electric Telegraph is that of the Telegraphic Fire-Alarm, originated by Dr. William F. Channing and Moses G. Farmer, for the city of Boston, in 1852.

From the central station at the City Hall, wires extend to every part of the city. These wires are called signal-circuits, and are five in number: by means of which the existence of a fire is signalized from any part of the surface of the city to the centre. In connection with these circuits are fifty signal-boxes, attached to buildings at convenient distances. They are of cast-iron and cottage-shaped (Fig. 75). On the door of each sig-

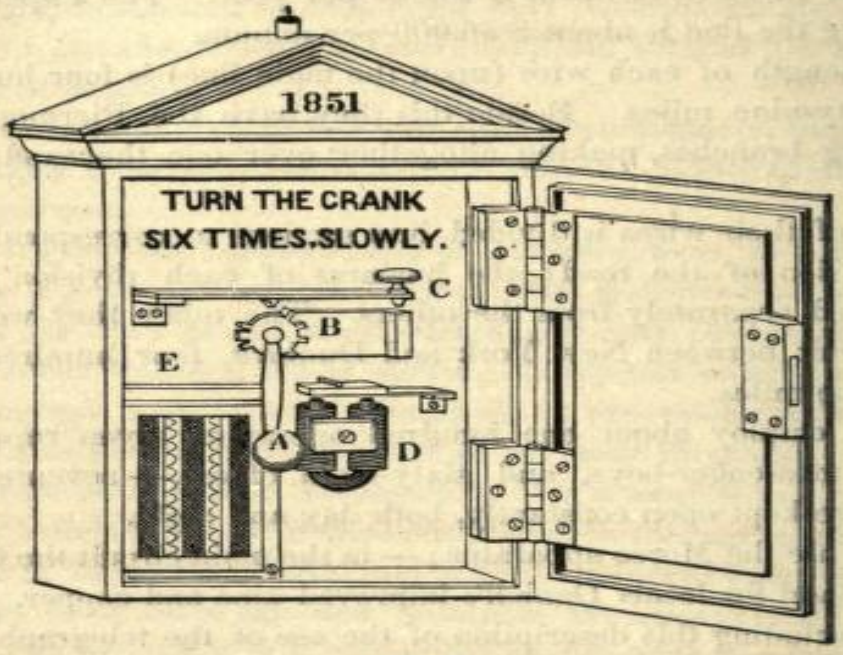

Fig. 75.

nal-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. Connected with this crank are the two signal-wires which extend to the central office, and by turning this 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 a correct signal will be given by turning the crank, however stupid may be the signalizer.

At the central office, alarm-bells are connected with the signal-circuits, and also a register which records the alarm received

from the signal-box. The battery which supplies the signal-circuits is 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 operator at the central station is instantly notified by the alarm-bell, and reads at once on his register the telegraphic characters which signify District 3, Station 5.

The characters used in the fire telegraph are dots to indicate the district number, and dots and lines for the station number.

The following is the combination: —

Districts.		Stations.	
1	-	1	—
2	- -	2	- —
3	- - -	3	— - -
4	- - - -	4	- — -
5	- - - - -	5	- - —
6	- - - - - -	6	— - - -
		7	- — - -
		8	- - — -
		9	- - - —
		10	— - —

Thus a dot, and a dot and line, would indicate District 1, Station 2; these alternate on the record, and are repeated as often as the crank is turned.

The apparatus used for recording at the central station is a modification of the Morse, and the alphabet for general use is the combination adopted by Bain.

Having described the mode of communicating the alarm to the central office, let us see how the alarm is given from that centre to the public. From the central station extend five 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 simply moving the pointer upon the dial of a clock placed in connection with the several alarm circuits, to throw all the striking machines into simultaneous action, and thus give instantaneous public alarm.

The heavy hammers which are used to sound the alarm upon the bells are run by weights, which in several instances are wound up by the force of the water compressed in the mains. 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 is obtained. 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 magneto-electric machine, which furnishes all the power necessary to work the apparatus of the alarm-circuits.

The Cochituate water is used as a motive power to carry the magneto-electric machine. This arrangement saves the expense

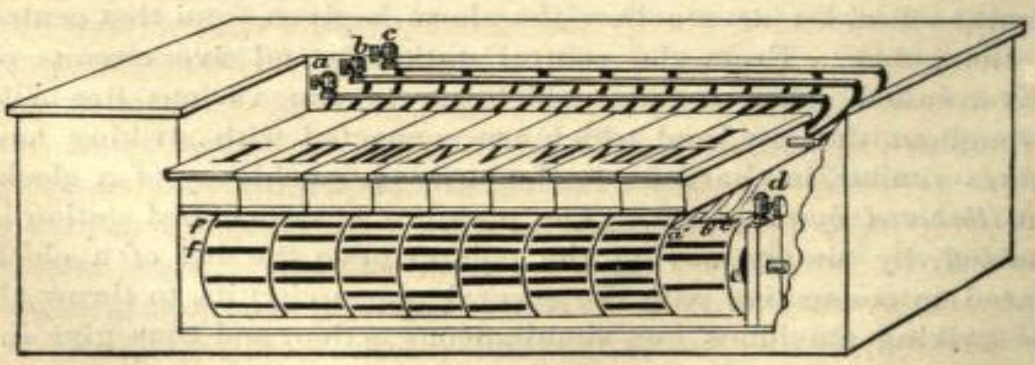

Fig. 76.

and inconvenience of maintaining a large quantity battery to work the alarm-circuits.

An ingenious arrangement of a cylinder (Fig. 76) carried by clock-work, upon the circumference of which are metal plates connected with the several alarm-circuits, enables the operator, by placing the pointer of the clock upon any number upon the dial, to set the machinery in motion, so as to complete the circuit at such intervals as to strike and repeat on the distant alarm-bells the district number represented by that number, with suitable pauses between.

We will suppose the operator at the central station receives the signal of fire from District 3, Station 5. He now places the pointer upon the dial upon the figure 3, and instantly all the alarm-bells in the city begin to strike synchronously the district number 3, and continue to do it, no matter what their number or what the weight of their hammer, so long as that pointer remains upon that number upon the dial.

The operator has also a key before him connected with the signal-circuits, by which he can answer back, and strike a little bell through the action of an electro-magnet armature, enclosed in each signal-box. He has received a signal of fire from District 3, Station 5. While the pointer rests upon number 3 upon the dial, he taps occasionally five times on the keys of the signal-circuits, which we 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 motion 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 Boston fire-alarm telegraph, both district and station are publicly notified, — the one by the alarm-bells, the other by the signal-boxes.

Let us now consider the analogy between the municipal organization thus described, and the nervous organization of the individual. A coal of fire falls upon your 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 plan 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.

In Boston, where the fire-alarm telegraph has been in successful operation for nearly eight years, a star of wires is seen radiating from the top of the City Hall. These are the signal

circuits, connecting into one system fifty signal-boxes scattered over the city, and the alarm circuits connecting twenty-three 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 means of the clock movement in the central station. For the sake of economy in battery power, the cylinder is so arranged as to throw the current from the magneto-electric machine in 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 Daniell's (sulphate of copper), which keeps in action several months by the addition each week of a few crystals of the sulphate of copper. Instead of a galvanic battery on the alarm circuits, a large magneto-electric machine has been substituted, similar in principle to those described in the earlier part of this work.

The heaviest hammer in the system at Boston weighs one hundred pounds, and 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 finger upon a telegraph-key a hundred or a thousand miles distant. The bells were rung, not long since, from Portland, and the Superintendent of the Fire-Alarm, Mr.

J. B. Stearns, had made arrangements to have them rung by telegraph from London just as the Atlantic cable ceased to work.

All the stations in Boston are provided with lightning-arresters, 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 attained 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-arresters have been in place, they have proved sufficient, except in rare instances, to direct 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 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 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-boxes, which are the sensitive extremities 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 mechanism of the fire telegraph is arranged and disposed for the purpose of preserving the 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.

Arrangements have been made by which uniform time is given to the inhabitants of Boston every day at noon by means of the

fire-alarm telegraph. An exact chronometer is placed in the circuit, which sends an electric current every day, at precisely twelve o'clock, and causes the hammer attached to the bell upon the Old South to strike one blow. This gives the inhabitants of the city an opportunity to regulate their time by a correct standard, and is a great advance upon the London system, which only drops a ball from a pole erected in the Strand, the telegraph wires being connected with the Royal Observatory. It is also much better than the Paris method of firing a cannon, which is touched off by telegraph. In the London plan, the few persons in the vicinity of the Strand only are benefited; and at Paris, the man who is half a mile distant loses several seconds, unless he makes allowance for the speed of sound; but in the Boston plan the whole city can be *tolled* the time to the fraction of a second. The public appreciate the system, and we shall doubtless soon witness the incongruity of people taking time from steeples that have no clocks in them.

The following interesting tables, showing the number of alarms which have occurred each hour, day, week, month, and year since the fire-alarm telegraph was established, in April, 1852, to January 1, 1860, have been computed by J. B. Stearns, Esq., Superintendent of the Boston Telegraphic Fire-Alarm.

Table I. shows the number of alarms in each hour during the twenty-four hours of the day in each year from 1852 to 1860, and the totals for the eight years, together with the number of blows struck upon the bells during the same period.

Table II. shows the number of alarms during each month of each year, and the totals for the eight years.

Table III. shows the number of alarms during each day of the week for each year, and the totals for the past eight years.

TABLE I.

Year.	Forenoon.												A. M.	Afternoon.												P. M.	Total.	No. of Blows.
	1	2	3	4	5	6	7	8	9	10	11	12		1	2	3	4	5	6	7	8	9	10	11	12			
1852*	2	3	6	1	4	0	2	1	3	4	2	4	32	7	2	6	3	4	10	7	6	10	10	9	6	80	112	4,806
1853	5	8	12	6	2	2	6	7	5	6	6	6	71	8	7	10	7	6	9	8	13	17	21	13	7	126	197	8,629
1854	15	8	7	8	6	4	4	2	8	4	3	9	78	9	7	2	7	10	9	10	11	12	9	12	10	108	186	6,575
1855	4	7	8	7	9	1	0	7	5	6	3	5	62	5	4	6	4	2	4	6	11	12	6	11	11	82	144	6,498
1856	14	9	7	7	6	3	1	3	3	6	3	3	65	3	4	10	9	5	5	12	8	15	11	11	10	103	168	8,689
1857	10	14	16	10	1	1	1	5	3	7	5	4	77	7	5	2	4	3	8	4	8	12	18	10	16	97	174	8,022
1858	8	7	8	6	1	2	1	0	7	4	2	5	51	7	7	10	6	4	6	3	9	12	9	11	16	100	151	6,695
1859	6	10	9	10	5	3	3	5	9	4	6	3	73	5	7	8	4	8	4	4	10	12	10	11	16	99	172	6,538
Total,	64	66	73	55	34	16	18	30	43	41	30	39	509	51	43	54	44	42	55	54	76	102	94	88	92	795	1,304	56,452

* Commencing April 28, 1852.

TABLE II.—Months.

Months.	1852.	1853.	1854.	1855.	1856.	1857.	1858.	1859.	Total.
January,		10	15	8	16	15	11	9	84
February,		29	20	13	10	14	10	11	107
March,		12	19	12	19	13	15	13	103
April,	1	21	10	13	29	11	10	11	106
May,	21	25	12	10	12	15	21	12	128
June,	5	25	20	16	9	15	13	11	114
July,	18	10	16	13	16	17	9	20	119
August,	8	11	15	12	10	16	7	23	102
September,	9	12	13	15	14	11	11	10	95
October,	15	17	14	7	9	22	14	21	119
November,	16	11	15	13	9	11	15	11	101
December,	19	14	17	12	15	14	15	20	126
Total,	112	197	186	144	168	174	151	172	1,304

TABLE III.—Days of the Week.

	1852.	1853.	1854.	1855.	1856.	1857.	1858.	1859.	Total.
Sunday,	16	30	27	12	22	20	23	29	179
Monday,	19	26	20	17	20	19	27	33	181
Tuesday,	16	37	31	24	26	31	30	20	215
Wednesday,	16	18	31	26	27	29	16	19	182
Thursday,	19	27	24	18	27	27	15	16	173
Friday,	11	23	26	20	27	24	16	23	170
Saturday,	15	36	27	27	19	24	24	32	204
Total,	112	197	186	144	168	174	151	172	1,304

The diagram (Fig. 77) is intended to exhibit the results of the past eight years' experience with the fire-alarm apparatus, showing in what hours of the day and night fires are most or least likely to occur. The diagram covers the twenty-four hours of the day, and is divided by the dotted lines into the forenoon and afternoon, and also into the portions between six o'clock A. M. and six P. M., and six o'clock P. M. and six o'clock A. M.

The outer, inner, and middle circles represent respectively the maximum, minimum, and medium periods of alarms.

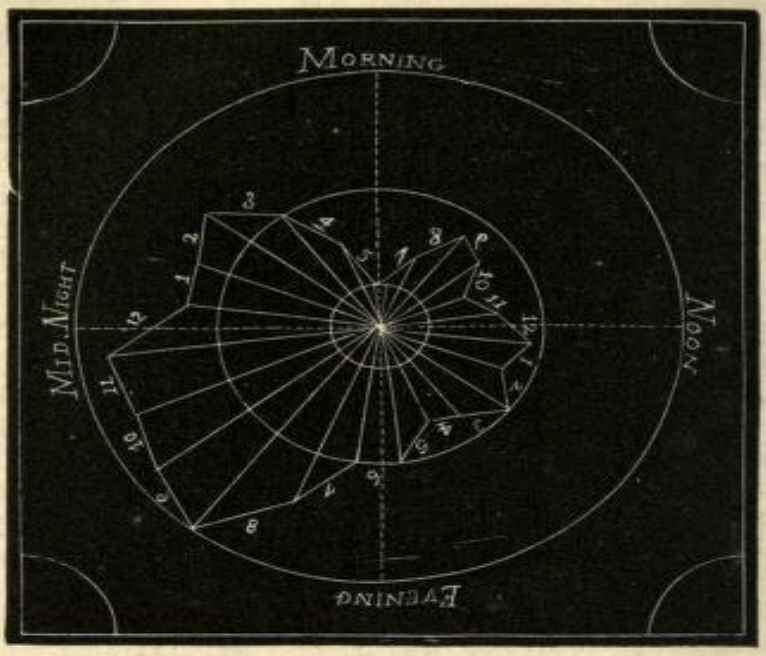

Fig. 77.

Thus it will be seen that the maximum of alarms occurs between eight and nine P. M., the minimum at six o'clock A. M., and the medium at precisely six o'clock P. M.

The larger number of fires occur between six o'clock P. M. and six o'clock A. M.; in fact, the angles in the other twelve hours of the day reach even the medium circle but twice, — between two and three, and five and six, — and do not extend above it in a single instance; while in the former part the angles do not drop below the medium circle until nearly four o'clock A. M.

Of the days of the week, the larger number of alarms occur on Tuesdays, and the next in number on Saturdays. This may be accounted for from the fact that Saturday is baking-day, and Tuesday is generally appropriated to ironing, — both requiring more intense fires than upon other days, excepting, perhaps Monday, washing-day, when there is always plenty of water for subduing any fires which may occur.