BIOGRAPHICAL MEMOIR

OF

FAIRMAN ROGERS.

1833—1900.

BY

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It was some time in the 70s, while strolling through the halls of the University of Pennsylvania, that the writer was presented to the subject of this sketch. The brief conversation which ensued served to impress him with the fact that FAIRMAN ROGERS combined in himself not only the qualities of an attractive gentleman, but that he was also the possessor of faculties which made him the easy master of many of the most difficult problems which had arisen or which might arise in that domain of applied science to which he gave many of the best years of his life. Indeed, the impression made in that brief moment was that Fairman Rogers was constantly seeking to give to everything attracting his attention most earnest consideration. Nothing was so trivial but that, to his mind, it might be applied to useful purposes. The impressions received then were but strengthened by the representations made of the man by those who had known him intimately from boyhood, into and through manhood. That he was versatile will be obvious to any one who will take the pains to study his accessible publications.

We are informed that before he entered upon his college career, when perhaps fourteen or fifteen years of age, he was called upon by the head master of his preparatory school to address his schoolmates upon the telegraph. This he did, illustrating his lecture by means of wires attached to the walls and ceiling of the schoolroom. It is not surprising, therefore, that this intensely earnest and capable lad should afterwards have devoted himself to some of the most difficult problems in engineering science.

It seems to be conceded that Fairman Rogers inherited his scientific inclinations from his father, Mr. Evans Rogers, an iron merchant; though perhaps they may have come down to him from his mother, Caroline Augusta, the daughter of Mr. Gideon Fairman, a noted inventor, to whom he probably owed those social charms for which he was so noted and which were so characteristic of his maternal grandfather.

As a boy we are told that Fairman Rogers was admired and loved by all who knew him. He was "an adept in riding, dancing, swimming, skating," and all the things which go to make up a well-rounded boy life, yet never failed to do his duty in connection with the studies of his youthful period. After completing his preparatory years he was admitted to the college department of the University of Pennsylvania in 1849, when in his sixteenth year, as he was born on November 15, 1833, in Philadelphia. As a college student he ranked high, his favorite studies being mathematics and the physical sciences, though there is no doubt that because of his close and intimate relationship with Dr. John F. Frazer, who then taught the classes in physics and chemistry, he was given an opportunity to indulge his preferences for such subjects to a greater extent than most of the young men of that period. Dr. Frazer saw in his pupil great promise, and took every opportunity to bring him in contact with the leading men of science. It was at the home of Dr. Frazer that Fairman Rogers first made the acquaintance of the elder Agassiz, who was at once attracted by the earnestness, keenness, and extraordinary ability of the young man. It was in this home, too, that he learned to know other eminent scientists, and in this way his predilection for scientific subjects was fostered and developed.

His college career must have been truly one of great happiness and profit to him, and it is not at all surprising that in the short space of two years after his graduation, in 1853, we find him again in real, active scientific work as an engineer, under that able, inspiring, and genial Superintendent of the United States Coast Survey, Alexander Dallas Bache, who continued a friend of Fairman Rogers throughout his entire life, and with whom in 1857, as a volunteer, he assisted in determining the Epping base line in Maine. It was not only in field work that he was active at this time, but he was also engaged in delivering lectures on civil engineering subjects to classes at the University of Pennsylvania, where he had been installed as professor of that branch. In addition, he lectured upon mechanics, including physics, in the Franklin Institute.

In January, 1856, occurred his marriage to Miss Rebecca H. Gilpin, and "forty-four full years of mutual devotion hallowed a union whereof the world affords only too few examples."

Among the publications during his period of professorial activity is one entitled "Lectures on the Construction of Roads and Bridges." These were delivered in the Smithsonian Institution, at Washington, in 1861. They consisted in an examination of the principles which govern the location and construction of roads and of bridges.

He said:

"It would hardly seem necessary to dilate upon the immense advantages which spring from ample and economical means of communication throughout a country. In this age of rapid locomotion they are strongly set forth in the prospectus of every new railroad project and are familiar to all; but, somewhat strangely, while we have covered our country with these iron ways we have the doubtful honor of having the very worst common roads of any civilized country on the globe."

In another lecture we find him saying:

"In a new and sparsely settled country the road should be quite narrow, since then it is much more easily kept in repair. * * * Near large cities roads should have a width of from fifty to sixty feet, or even more. The surface must be such as will remain smooth and not be easily affected by the weather. * * * Drainage is one of the first objects of the engineer. * * * Every precaution must be taken to carry off the water which falls upon the surface. * * * The preparation of a road-bed to receive a coating of broken stones has been the subject of discussion between two eminent road-makers in England—Telford and McAdam; and opinion is still divided between the two systems proposed by them, although that of the latter, having the advantage of less first cost, has been most generally adopted. Telford, the engineer of the Holyhead road, thought that the stones should be laid upon a rigid foundation, and he therefore paved his road-bed with thin stones set on edge and laid the covering on that, considering that the stones would not in that case be forced out of place into a yielding surface below. McAdam, on the contrary, contended that the road covering thus placed between the wheels and the unyielding pavement would be rapidly ground to pieces, and that an elastic substratum is necessary to prevent such action. He consequently laid his road covering upon the natural

soil. * * * A difficult engineering problem has always been to find a good material for city streets."

At this rather distant day the ordinary layman reading these lectures becomes intensely interested. They undoubtedly were planned with the idea of making much-needed improvements, and they are presented in such an attractive and simple form that a non-technical person can comprehend and grasp all the important points. The illustrations accompanying these lectures are extremely simple and lend greatly to a clear understanding of them. One feels that they were written by an earnest student of engineering science. It was during this period also that Professor Rogers was chosen to lecture at Harvard University.

In 1861 he served as first sergeant of the first troop of the Philadelphia city cavalry in its three months' campaign. When mustered out he returned to his lectures at the Franklin Institute and to his classes at the University. It was about this time that he delivered a course of lectures on "Glaciers," at the Smithsonian Institution, in Washington, and made a survey of the Potomac for the United States Coast and Geodetic Survey. In the fall of that year he enlisted as a volunteer engineer officer with the Pennsylvania militia and took part in the campaigns of Antietam and Gettysburg. At the close of the war he was chosen captain of the first troop of Philadelphia's city cavalry.

In 1863 the National Academy of Sciences was instituted by Congress. Professor Rogers was one of the fifty original members and became the Treasurer of the Academy, serving in that capacity for a number of years, as well as upon its council and upon various committees. As it was one of the functions of the Academy to conduct investigations for the United States Government, Professor Rogers was requested to make a study of the compasses of the iron vessels then in the service of the government. They were sent to the navy yard at Philadelphia for his convenience, and there the work was carried on in a most able, conscientious, and satisfactory manner. This investigation led him to prepare a treatise on "The Magnetism of Iron Vessels." It was published later as one of the van Nostrand Science Series.

"It does not contain any material hitherto unpublished, but it is intended to give to an officer previously unacquainted with the subject sufficient information to enable him to undertake a series

of observations which would be of value in adding to the general knowledge of the subject, or in studying his own ship so as to avoid mishaps from a too firm reliance upon uncorrected compasses or from unexpected changes in new magnetic latitudes. * * * The treatise is offered to those engaged in navigation, especially to yachtsmen and scientific travelers, as a simple introduction to the subject and a guide in such observations as they might feel disposed to undertake."

Here again is further evidence of the fact that Professor Rogers' efforts, no matter what form they took, were inspired with the idea of extending the confines of human knowledge. The lectures upon road-making, to which reference has been made, and the little volume from which the prefatory sentences have been quoted show each, here and there, this praiseworthy object. This is observed again in the concluding lines of the little book on "Magnetism," for they read: "Every officer commanding or on board an iron vessel may add his share to perfecting the general knowledge of the subject by well-devised and carefully executed experiments and observations."

Truly the incentive to research and the application of scientific principles to the betterment of mankind, which were undoubtedly instilled into the mind of Professor Rogers by his teachers and friends, Frazer and Bache, remained constantly with him and cropped out at all times in his work, whether of a private nature or of a public character.

The catalogue of the University of Pennsylvania for the year 1871 bears the name of Fairman Rogers for the last time as a teacher in that institution. It was now transferred to the page upon which appear the names of the trustees of that venerable university, where for nine years it shone forth as an indication that in the conduct of the affairs of the university it was the purpose of its guardians to entrust the same to men worthy and capable.

In 1881, when the revered Dr. Charles Janeway Stillé laid down the duties of the office of provost of the university, Professor Rogers was earnestly requested to take up the work of Dr. Stillé, but for reasons best known to himself he declined the honor. It was shortly after this that he severed his connection finally with the university. But he was not idle. He became

deeply interested in the Academy of Fine Arts, and in 1881 published a most readable and interesting article on that institution, in which article occur words like these:

"It is necessary to bear in mind distinctly that these schools are supported in the interest of those who intend to become professional artists, that is, persons who expect to devote themselves to the production of pictures and statuary. * * * Those who, like lithographers, china painters and decorators, need nearly the same kind of education for their pursuits, are cordially welcome, and amateurs are at liberty to make what use of the school they can as far as its means and space permit. * * * With a very limited amount of money to spend, the effort is being made to carry on a school which in principle at least shall compare fairly with the best of those abroad. It must be left for the public to decide, upon the merits of its graduates, how far its promises are fulfilled in the future."

At this time Professor Rogers was chairman of the Committee on Instruction. He served the Academy for a period of twelve years. Under his direction its system was wholly reorganized, so that it attained the highest rank in this country.

Among the publications of Professor Rogers lying before the writer is a pamphlet on "Horsemanship." The instructions set forth in this pamphlet cannot fail to be read even today by any one interested in the horse with the intensest interest and sympathy. In the words of its author,

"Horsemanship had been and with most persons is still an art. Some men are born to be horsemen, as others are born to be musicians. * * * It is as impossible to make, by any course of teaching, a rider of a man whose body and mind are not suited to it as it is to make a musician of a man without an ear, although one may with perseverance be taught to sit upon a quiet horse and the other to play a simple strain. This difference existing in men, it is of some importance if the horse is to be ridden for general purposes, military or civil, that horsemanship should be reduced to a *science* as far as possible; or, in other words, that fixed rules, based upon correct principles, should be established, which will enable the instructor to teach and the pupil to understand up to a certain point, beyond which the rider's own genius must be depended upon."

Again we have, in these few words, the effort of our colleague to introduce system into pleasure as well as into a utilitarian practice. He proceeds:

"It is absurd to suppose that while by properly directed practice a man may increase the strength of certain muscles and the flexibility of certain joints, the horse cannot be improved mechanically in the same manner. There are many horsemen who seem to think that a well-made, active horse ought to do without previous education everything that any horse can do as soon as he can be made to understand the will of his rider. As well might we expect any active, well-formed young woman, without practice and yet with the strongest will, after having witnessed one hundred representations, to perform the movements of an Ellsler or a Cerito."

It was in this way that he introduced or called attention to the great system of training for horses as proposed by Baucher. "For," he adds,

"Baucher insists upon gentleness, kindness, patience, and appeals to the understanding of the animal in all stages of training, coupled with courage and decision, for indecision is sometimes most provoking to an animal with which we cannot communicate directly by means of language; in other words, the trainer must have a clear idea himself of what he wishes to do and must not change his mind just as the operation commences, or he will worry his horse, or, as Baucher says, 'shock his understanding.' The horse should be made to understand that the man can by some power combat his most vigorous exertions and conquer him. This 'breaking' was performed by 'rough riders,' who by harsh and sometimes brutal treatment reduced the horse to a state of subjection; but happily there is no longer any excuse for any brute who may thus treat the animal destined to serve man's pleasure, for there are methods, based upon true principles, by which the horse, however wild and savage, finds himself without pain or injury inflicted upon him, suddenly and in the most mysterious manner, completely in the power of his weak master, and sooner or later gives up with a good grace and with his power and spirit unimpaired. Thus subdued, he must next be taught the power of the bit and saddle, and must go through a course of gymnastics to enable him to do what his rider requires. When a

horse runs at liberty in the field his step is springy and free, depending in degree, of course, somewhat upon his natural conformation, and if he is ordinarily well formed his muscular forces are exerted in such a way as to keep his body in a condition of equilibrium. All this comes naturally to him as walking does to a child; but when we place upon his back a weight equal to one-sixth of his own and expect him still to be as graceful and as easy as when

"'Free he roamed the grassy wild,'

we are expecting rather too much of him. If any one doubts this, let him put thirty-five pounds in a knapsack or take a child pick-a-back and attempt to execute gracefully a walk, a dance, or a bow. He will find a noticeable change in the position of his center of gravity and a decided sense of heaviness on his legs, the effect of which it will take a considerable amount of loaded drill to overcome. * * * Baucher commences his instruction with a simple lesson. Standing in front of the horse, he taps him on the chest with the whip, keeping up the light blows as long as the horse retreats from them, instantly ceasing the taps and caressing him when he comes forward; and in a short time the horse, finding that to avoid the punishment he must move forward and not backward, advances upon the slightest touch; and the first method of communication is thus set up with him. Then, since the communication between the hand of the man and the mouth of the horse is by means of the bit, attention must next be paid to its action. The horse has two ways of resisting the pressure upon the bit—by closing his mouth and holding his jaw rigidly fixed, and by extending his head and neck into as nearly a straight line as possible, either by throwing both down or by throwing both up. The first of these is overcome by the flexions of the jaw. The jaw being flexed, the neck must be attended to, and by the proper pressures on the bit the horse is made to understand that he finds relief when he holds his neck well up and his head in a vertical position, that in which in reality he can oppose the least resistance to the hand of the rider. By these flexions we not only teach the horse to do a certain thing, but the exercise enables him to do it, the muscles which sustain the neck being strengthened and the neck rendered more flexible, especially near the head,

where the new curvature of the neck may be distinctly seen when, as horsemen say, the neck is broken. The flexions of the neck are not painful to the horse, but they are somewhat fatiguing, as is a new exercise or a new position to a gymnast, and they must therefore be practiced with judgment so as not to disgust the animal with the operation. Having thus educated the head and the neck of the horse, the other parts of the body are attended to, and thus the mechanical resistances are overcome which interfere with the movements that the animal is required to make. The use of the whip and the use of the spur receive careful attention, and it will be observed that the gaits of the horse are improved. They become more springy, and the balance upon the feet such that the movements of the rider are more readily communicated to him."

Throughout the entire communication from which these quotations and paraphrases have been made the spirit of scientific interest is maintained, and the concluding words are:

"If riding is indulged in as a pastime, let it be carried to the highest point of perfection; if it is a necessity, as in military service, let all know how to do it in as comfortable and agreeable a manner as possible, and neglect no means to attain this desirable end."

The last contribution of Fairman Rogers was his "Manual on Coaching." This he prepared after devoting a number of years to the subject in a practical way. It is a volume of almost 600 pages, and in it there is evident everywhere the desire of the author to introduce scientific principles. Thus, in chapter IX. after speaking of the weight of the coach, the author continues:

"We now come to one of the divisions of our subject important from a practical point of view—the position of the center of gravity of the coach. The center of gravity of a body is that part in which its whole weight may be considered as concentrated; in a symmetrical body of equal thickness and equal density in all its parts it is at the center of the figure of the body. For example, a square piece of board of even thickness will have its center of gravity at the point at which its two diagonals cross. If at that point we bore a hole and hang the board on a smooth pin the board will remain in any position into which we turn it, because

the center of suspension and the center of gravity coincide. If we suspend it from some other point we will find that the board will hang steadily in one position only, namely, when the center of gravity is vertically under the point of suspension. If we flatten one corner slightly we can make the board stand upon it, but it will be in unstable equilibrium, and will fall to the right or to the left at the slightest touch. We therefore say that the board is in equilibrium when the center of gravity is vertically above the point of support. Conversely, the center of gravity is above the point of support when the body is in equilibrium. Now, a coach looked at from behind is symmetrical as to the distribution of its parts about its vertical center line, and its center of gravity must be therefore somewhere in that center line. If we tip the coach on the two wheels of one side until it exactly balances and would fall to either side, the center of gravity must be in a vertical line passing through the point of support, and since it is always in the center line of the coach it must be at the intersection of these two lines. We can determine by this experiment the angle at which the coach will tip over, or, what is the same thing, the elevation of the wheels of the higher side which will cause it to balance. * * * If from going fast over a bad road or from the horses galloping unevenly the coach gets to swinging laterally, the higher the center of gravity the more readily will the coach turn over, since it is obvious that a horizontal force applied to the coach near the top will pull it over more readily than the same force applied nearer the ground. The danger in turning the corner is increased by a high center of gravity. A body in motion has, by reason of its inertia, a tendency to continue its motion in the original direction until it is acted upon by some exterior force. A coach going along a straight road is deflected when it comes to a corner by the horses pulling it around the turn. It has, however, a tendency to keep on in a straight line, and this tendency is shown as a force acting at right angles to the direction of the coach, pulling it outward from the circle in which it is moving. This is called the centrifugal force. * * * This force varies exactly with the weight. * * * With a known weight of coach the centrifugal force corresponding to any speed round a turn of any

radius may be computed. The formula for this computation is as follows:

$$\text{"centrifugal force} = \frac{wv^2}{32.2r},$$

where w = weight in pounds; v = velocity in feet per second; and r = radius of curve in feet, etc."

And in another chapter the author gives a mathematical demonstration of the amount of power (draught) required to overcome a resistance to the motion of the vehicle from two points of view—first, the actual mechanical force expended, and, second, the way in which that force should be applied by an animal. The question of axle friction, ball bearings, the effect of grades, etc., are duly considered. The paragraphs relating to the action of a horse in draught, his attachment to the traces, etc., also receive careful thought. There seems not to be one point that is not touched upon by the author in this admirable publication. To produce the evidence of this statement would require more space than we can justly give to this contribution. A few paragraphs, however, may be here introduced. Thus:

"A coachman should sit straight and square to the front, his shoulders back and his knees and feet close together, his toes not projecting beyond the edge of the footboard. It is hardly necessary to add that he should never cross his legs or have one foot in advance of the other. If he sits with his feet drawn back, off of their proper place on the footboard, he is simply preparing himself to be thrown on his wheelers' backs in case of striking a stone or post. The whip is held by the right hand at the ferrule, and at an angle of 45° from the horizontal and 45° to the front. In this position the thong is above the one-wheeler, and the whole whip is out of the way of a person on the box. If it is near to this passenger a sudden touch of a branch in passing will drive the whip back into his face before the coachman can stop it. If it is too low the loop of the thong may touch or catch on passing vehicles."

This final work of Fairman Rogers must be regarded as a classic in its domain, and, as the writer has repeatedly said, it shows how the mind of its author was constantly turned to his

special subject of engineering and introducing science into everything in which he was interested.

Some years ago numerous and most interesting experiments were carried out at the University of Pennsylvania by Professor Muybridge upon the photography of animals in motion. It is believed that the principle employed by Muybridge was suggested by Professor Rogers. Similar adaptations of this principle, which is that of the zoötrope, are also found in the biograph and the cinematograph.

Photography claimed the attention of Professor Rogers forty-five years ago, and it is mentioned by his friends that one of the very first typewriters, perhaps the first, was set up in his library by the inventor, and there is every reason to believe that the attention Professor Rogers gave this instrument led to suggestions in the way of improvement and betterment that were gladly received by the inventor.

Professor Rogers loved flowers, pictures, and books most passionately. Books in his specialty of civil engineering he collected in great numbers. They were most complete. They constitute a part of the library of the University of Pennsylvania today, as does his remarkable collection of works on horsemanship.

The Union League, a club of Philadelphia favorably known all over the country, had Professor Rogers as one of its founders. He was also a member of various riding and hunting clubs, of the American Society of Civil Engineers, and of the American Philosophical Society. He was indeed a many-sided man, and after giving up his engagements in this country and going to Europe for a rest, his mind remained active. He could not be idle, and it was then that the "Manual on Coaching" was written. The book was evidently most kindly and heartily received. The volume which the writer has had the pleasure of examining was drawn from a public library, and shows that it must have been in frequent and constant use since its deposition there. How fortunate it is that the author lived long enough to enjoy this recognition of his labors. Five years ago, at Vienna, on August 22, 1900, the spirit of Fairman Rogers was called hence, and in the language of the scholarly Dr. Horace Howard Furness, who knew him long and well—

"A choicer spirit has seldom visited this earth. To a keen intellect were united clearness of exposition and a retentive memory. Warm and loyal in his friendships, he never cherished an ill feeling, for no one ever did him an unkindness. On many an institution of his native city an ineffaceable impression has been left of his judicious devotion; of unstinted hospitality and the most considerate and attentive of hosts; of such exquisite urbanity that although emphatic and inflexible in his mature convictions, he was never known to give offense in expressing them; of high veracity and a delicate sense of honor, and of such imperturbable serenity that it may be said with absolute truth that a harsh or hasty word never fell from his lips.

"Possibly it may be thought by those who did not know him face to face that in what has just been said there is too much of the 'personal equation.' Be it so. We were children together, boys together, men together, brothers in love and in law. I can but say what I believe."

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