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The attempt to utilize compressed air as a motive power for street cars in cities, appears to have been most unsuccessful. About four years since, a company was organized in New York city for the purpose of building street cars on the pneumatic system, capable of replacing those drawn by horse power, and about the early part of April, 1878, a passenger car propelled by compressed air was running on the Second avenue, New York, between 63d and 93d streets.

The experiment was considered perfectly satisfactory for a first attempt, as the cars performed their work admirably; and the public press and various eminent engineers considered the problem solved. There was, however, an essential element of success that was wanted, which appeared insignificant at the time, but which proved fatal to the whole scheme. This was a failure on the part of the engineers to design machinery which should be constant in its working, requiring little attention from the driver.

It was supposed that in building future composite pneumatic engine cars these defects could be remedied. But when the six cars built on this principle were placed on trial, the same trouble was experienced, and the experiment was abandoned, causing a considerable pecuniary loss to the promoters of the company.

The Pneumatic Tramway Engine Company, undaunted by past losses and failures, have renewed their efforts, and have recently constructed a pneumatic traction engine, which we understand will be immediately placed on trial on one of the New York elevated railroads. The successful working of Electric Railway Engines has probably increased the difficulties of those who are advocating the use of

compressed air as a motive power. In the absence of smoke, odor, noise and cinders, both the electric and compressed air systems have many advantages over steam for elevated railroads, and the question of economy will probably decide which system shall be finally accepted. At the present moment all the advantages appear to be in favor of the electric railways for use within city limits, and it is probably a mere matter of time, for all the New York elevated railroads to be running their trains by this system.

THE STATE AND HIGHER EDUCATION.*

BY PROFESSOR N. H. WINCHELL.

The incentive to the following address appears to have been certain remarks made officially by President John of Hamline University, who considered that "higher education should not be under the control of the State," and that the design of the State Colleges has been a conspicuous and universally acknowledged failure.

In the first part of the paper Professor Winchell presents an historical sketch of the circumstances, the result of which was "that the State finds itself in the conduct of systematic education."

After tracing the progress of education in Europe he states:

Thus we find that none of the old universities, except when under the control of the government, and sometimes not even then, have been willing to modify their curricula in compliance with the demands and spirit of the age. If they have done it, as more lately at Oxford University, it is only after the force of public sentiment has been able to batter down the walls of prejudice and conceit with which they have been surrounded. During this whole conflict throughout Europe the Church, in its various forms, but particularly the Roman church, instead of being the champion and refuge of free thought and free knowledge, has been the most powerful obstacle to its progress, and has persistently opposed every movement to introduce the means for disseminating useful knowledge among the people. The heat of the conflict is passed. The tide has set in the right direction. The old universities perceive the triumph of modern science. European governments are unanimously striving for the establishment of modern schools of science on the broadest foundations, and equipping them with the fullest appliances.

Now let us turn to America, and inquire how this history has been mirrored on our institutions of higher learning.

In the first place the church colleges that arose in this country prior to 1824, or even later, were modeled after the mediæval universities of Oxford and Cambridge, so far as they expanded into the dimensions of a university. For the most part they were simply colleges of classical lore, with but one course of study, aiming specifically, at first, to educate young men for the clerical profession. As they were born of the English universities, so they inherited their mediæval narrowness and bigotry. As the early church had grappled with Copernicus and Galileo, and had been worsted, so the later church would grapple with everything that bore a resemblance to or intimation of any new fangled notions of nature. Although the world had made wonderful strides in human knowledge, the colleges shut their eyes and ears to the change. The age demanded education in the great industries that characterize modern society, but could get only that of the age of Elizabeth. As modern science and civilization began to buzz about their doors, they drew themselves within their shells, affrighted, like snails. Having none of the elements of the

* Delivered before the Minnesota Academy of Natural Sciences, Jan. 12, 1881.

new light within them, they were literally enslaved to themselves and could not escape. They began to sink in public esteem. Their graduates failed conspicuously in competition in all the affairs of life with self-made men. Finally, in view of this disparity between the demand and supply of industrial and scientific instruction in America, a far-seeing and generous business man, Stephen Van Rensselaer by name, came forward with private means, and became the first to endow, in America, a "school of theoretical and applied science." This was done in 1824, and it is located at Troy, New York. Twenty years later the first voluntary effort was made within one of the old church colleges of America to regulate the curriculum so as to conform to the new demands, and although pushed by one of the ablest educators of America, Francis Wayland, in his own institution, and with his own denomination, at Brown university, the movement ended in a conspicuous defeat of the "new education." After the successful establishment of the Troy Polytechnic Institute, the example of Van Rensselaer was followed in Connecticut by Joseph E. Sheffield in the founding of the Sheffield Scientific school, which became attached to, but by no means recognized as co-ordinate with, the old line course in Yale college. This was in 1860. In 1847, soon after the failure of Dr. Wayland at Brown University, Abbot Lawrence endowed the Lawrence Scientific school at Harvard college.

About this time the legislature of the new States of the West began to express the sentiments of the people. In Illinois conventions met in 1851 to consider such means as might be deemed expedient to further the interests of an agricultural community, and to take steps toward the establishment of an agricultural college. They met not as Presbyterians, or Methodists, or Romanists, but as an agricultural community. The next year petitions were sent to Congress for the endowment of industrial universities in each State. In 1850 the agricultural college of Michigan was provided for by the State constitution, and went into operation in 1855. The scientific course of the University of Michigan was ordered by the State legislature in 1851. In 1858 Iowa appropriated money for a model farm and an agricultural college. In Kentucky, under the guide of Regent Bowman, an institution, chartered in 1858, had been established for "diffusing education among the industrial classes." In Pennsylvania an agricultural college was established in 1854, and in Maryland in 1856. In New York, as early as 1837, a project for establishing an agricultural college at Albany was entered upon and a site was selected. This resulted in failure. It was revived in 1844, and again failed through the death of a liberal friend of the enterprise; but in 1856 the State Agricultural Society of New York induced the legislature to appropriate \$40,000 for a college of agriculture. This institution was established at Ovid, and died when the war of the rebellion broke out in 1861. The People's College, at Havana, N. Y., intended entirely for the industrial classes, was at first offered the national agricultural land grant of New York State, but failing to comply with the conditions imposed by the legislature, this fund was passed to Cornell University at Ithaca. These institutions, all established prior to the year 1862, when Congress passed and the President approved the great educational land grant law had come into existence in compliance with the demands of modern civilization, and not at the instance of the church colleges, but often in the face of obstacles and discouragements thrown in their way by the church schools. But President John says that the "facilities of higher education existed in this country, and met all demands, before State colleges were thought of." With the single exception of Yale College and Hamline University at Red Wing, which established a so-called "Scientific Department," the former in 1846 and the latter in 1857, not one of the church colleges, so far as I have been able to learn,

showed the first symptom of knowing, much less recognizing, the difference in educational need between the age of Bacon and that of Lincoln.

The soil, therefore, was all ready for the seed. The bill introduced by Mr. Morrill of Vermont was vetoed by conservative Buchanan. Passed again at the instance of Mr. Wade, with only seventeen opposing votes, it was signed by President Lincoln on the 2d of July, 1862. It has been said that times of war witness the birth of great ideas and the initiation of great enterprises. It is true that in the United States, with the establishment, through rivers of blood, of the national idea, was also established the idea of higher education by the State as one of the justifiable means, in a republic, of self-defence and self-perpetuation.

This is all passed now, nearly two decades ago. If we proceed to inquire what has been its effect, we shall be able to answer another of President John's surprising statements. Is the design of the law establishing these industrial colleges by Congress, "a conspicuous and universally acknowledged failure?"

One of the first effects of this land grant by Congress was an awakening in the church colleges, then existing, to the value of the public domain as an educational agency. This was so rapid, and so great, that some of them succeeded in capturing the whole fund almost before the people knew it had been given to them. In others, along with a compliance with the terms of the act, the State demanded representation on the controlling board; but in most cases the church colleges were passed by, and new institutions were founded by the various States, though still, in many cases, combined with some other State or private fund.

In the second place, this law, which has so positively been pronounced a failure, brought into existence up to 1876, about forty schools of agriculture and mechanic arts, often styled national schools of science. These have come into existence since 1862—except in three States where similar institutions had already been endowed by State funds. In some cases also the fund was applied by the State legislatures to rejuvenate weakly scientific institutions, or further endow those that were flourishing. In the meantime, since 1862, the various churches of the United States had founded, up to 1876, 106 denominational schools. Some of these are based on broad foundations, and, like Hamline University, offer the student the most complete scientific as well as classical and literary culture. While the national schools of science are mainly confined to their own sphere—the primary intent of the law creating them—the new church schools cover all the fields of knowledge. It cannot certainly be unjust to them to compare their patronage by the youth of the country, with that received by the State schools. This, perhaps, will throw some light on the question of their asserted failure.

The 106 denominational colleges, established between 1862 and 1876, both inclusive, as reported by the Commissioner of Education, are found to be giving instruction to 13,757 students, including all departments, preparatory and undergraduate, in all branches of knowledge, from theology to chemistry and engineering, giving them an average of 130 students for each institution. Of these students, 9,066 are reported as in the preparatory (or secondary) grade of study, an average of 85 for each institution; and 4,691 are reported in undergraduate studies—an average of 44 for each institution.

Taking the same authority for the statistics of the forty State schools of agriculture and mechanic arts, and including only those students that are strictly in those departments, wherever a pre-existing college received the congressional grant, we find 4,891 students, which gives an average of 122 for each institution. Of these, 631 are reported in preparatory (or secondary) courses, and 4,260 in the undergraduate courses of study. This gives the state schools an average of 16 in the prepara-

tory classes and 106 in the higher classes. Thus it can be seen that, as institutions of higher learning, the attendance on the new church colleges is but 41 per cent of that on the State colleges. Hence, if the law of congress which called into existence these State colleges be a failure, how much greater the failure of that sectarian spirit which called these 106 denominational colleges into existence.

Another remarkable effect of this movement toward popularizing higher education in America was the renovation and elevation of the church colleges, then existing, and the establishment of numerous others with much broader and a more liberal scope of instruction. This of itself has resulted in immense benefit to education, as well as to the church in America. This effect is as important as the creation of the State schools themselves. The church has always been the principal agent of higher education, at least in the United States, and the recognition, by these institutions, of the great underlying truths of nature, and of the ministration of her laws to the daily comfort of man, is an epoch in the history of the nineteenth century, which, in its effects on the race, will exceed all other achievements of the "new education." It will contribute not only to the spread of science, but also to the spread of Christianity, particularly among those intelligent classes of the people who have been hostile to it, or indifferent, because of the attitude of the Christian church toward the truths of modern science. If the church once recognizes the fact that every enlightened nation is in arms against its supine adherence to mediæval education, and condescends to place itself in harmony with the truths of creation as well as revelation, one of the greatest obstacles to the evangelization of the world will be removed. It is easy to see that the material aspects of modern civilization are rapidly penetrating unchristian and uncivilized nations, outstripping the church in evangelizing them. How much better it would be if the two agencies could go harmoniously together into the same field, co-operating to accomplish the same end.

What has been said, so far, relates to the past. A few matters of fact have been stated. They pertain to the title, by which the State received, and holds, the educational structure which she has occupied. But President John not only disputes the title, but also the right of the State to occupy this field. We admit that force does not always coincide with right, and that, although nine points in the law are established when peaceful possession is proven, the tenth point may have the right on its side. Let us enquire, then, if there be a consistent reasonableness in the State's attempting and continuing to do this work. We shall not attempt here the justification of the State in establishing and maintaining primary and secondary schools. It is not demanded. In passing, however, we will except President John's definition of the duty of the State to educate. He fixes it at the "limit of necessity to preserve its own existence." So let it be. We shall recur to it again. But, specifically, as relates to higher education, the leading objections that have been urged are the following: (1) The personality of the State. President Elliot has fully presented this objection. It is foreign to the free spirit of American republicanism to witness the controlling influence and authority of the State in social and educational affairs. It smacks of the divine right of kings, and is a reminder of the despotism of Europe, two centuries ago. Now all this may be an objection in monarchical governments, but it seems rather strange that any promising educator in republican America should forget that here the people are the State. There is no kingly personality interfering with the domestic and social institutions of the community. The authority that controls is the aggregate will of the community. The chief right of the State's power is to conserve this aggregate will. Such an expression of the will of the people is voluntarism in

the discharge of its highest organic function, and is not "paternal government." (2) Again it is objected to State education, that it tends to uniformity, and not to variety, reducing all pupils to the same pattern, and smothering the aspirations of genius which spurns conventionalities and revels in the gratification of its own idiosyncrasies. This objection is more valid in the lower schools than in the higher. In the higher schools it is very questionable if the institutions of the church would be as lenient with idiosyncrasies in pupils, as those of the State. Judging from the past it would be folly for a student with an idiosyncrasy of genius to flee to a church college for its indulgence. We cannot see how this objection applies more fully in State colleges than to church colleges. In fact it is one of the necessary sacrifices which an individual has to make, when he becomes one of an organized community. He receives the benefits of combined effort in all directions, and he has to surrender the personal freedom to act in certain directions in which his action would transgress the aggregate good of the community. The schools are for the average pupil—both State schools and church schools—and he with an idiosyncrasy will look in vain for a place to disport himself. (3). It is urged again that it is not economical. Because, forsooth, a sectarian zeal demands denominational colleges, and "cannot conscientiously accept this service of the State," and will maintain colleges of its own, therefore the State cannot rightfully duplicate these institutions and tax the denominations for their maintenance. Not to mention the brevity of the time elapsed since the sects were willing to "do the same kind of work" as the State University, it is enough to reply that this argument applies against all State organization for education. The Roman Catholic insists on maintaining his own hospitals, and objects to taxation for public schools. The Atheist opposes the public tax because in these schools is taught the idea of a God, the Jew because the New Testament is read, or the Protestant because it is not. This argument against the public schools may be applied with equal reason against the State's management of the deaf and mute. At least, certain medical fraternities might use it because they cannot "conscientiously" endorse nor accept the methods of treatment practised by the State. (4). But the fourth objection, after all, is the chief one urged by the opponents of State schools—they do not correctly indoctrinate the student in matters of religious dogma. It is said that "the State by self-imitation cannot teach religion." This assertion the State accepts, and would fain leave it to the proper agent, yet the State is not therefore "prohibited by statutory limitation from throwing the least safeguard around the minds of our youth," which is one of the surprising inferences of President John. The State in its educational operations will always be governed by the aggregate sentiment of the people. Those fundamental ideas of religion, which are accepted by all sects, the State institutions will be compelled to teach. If, peradventure, for a time they happen to lapse from this high duty, the will of the community will sooner or later be restored. They are creatures of the people. They will teach what the people can agree on shall be taught. While they must not teach sectarian dogma, they must not become centres of atheism nor of infidelity. If they did either, they would not long survive. Like the schools of Switzerland, they are based on the "principles of Christianity and democracy." The special, political and denominational application of these broad platforms is left to party politics, and to various sects.

We venture the assertion, however, that when the true kernel of this objection is found, it will not consist in a fear of the non-inculcation of these truths by the State, but in a jealousy of the sects, one against the other. Education by the church has been considered essentially the training of the youth and doctrines of the

catechism. Though greatly extended in scope, it is still animated by the same cardinal principle. Each sect must defend itself by teaching its own dogmas to the youth, and, though every State college were to be abolished, there would be still as great a reason for maintaining all the denominational colleges. How long it would be before they would degenerate to the condition of mere sectarian propaganda, as before the revival, no one can say, but there would be a strong tendency in that direction. Freed from the competition of State colleges, their zeal in the teaching of science would soon lag. Not having ready access to the public means and resources of instruction, such as the State archives, maps, authorities, explorations, surveys, statistics, and to the avenues by which the State knows and readily regulates the great industries of the people, the church colleges would very soon see that there is an actual incongruity in their assuming to direct the scientific and industrial education of the people. It is the chief business of the church to look after the spiritual well-being of the people and not to fit them to carry forward the complicated machinery of modern civilization. Religion is the lubricator of this vast system, and the church is the agent by which it is applied. When the church departs from this sphere, she forsakes the true idea of the primitive church. When she leaves her spiritual kingdom and assumes to direct in the construction of steam engines, in the handling of theodolites and compasses, in the management of cotton-gins, in the measurement of the angles of crystals, and the distances to the stars, she may very reasonably be held to be out of her sphere. She has the privilege, of course, of doing all these things, and there was a time when she had good reason to do them, and was urged to do them, as the only capable agent; but that time has passed, and it can hardly be considered to be her duty to do them in the nineteenth century, when other agents equally capable have arisen, endowed with that special duty and function.

One of the boasted advanced steps of the nineteenth century is the separation of the church and State. In the mere manipulation of the governmental machine this is fully realized in the United States, and in much of continental Europe. But the administration of the laws is not the State, nor, indeed, is the making up of the laws, nor both of these united. True statesmanship surveys the whole body politic. It foresees and often institutes national enterprises. It watches the external and also the internal influences that move the masses; it takes advantage of the shifting markets for the domestic products. It notes the rise and decline of the various industries. It applies stimulants when needed and repression when necessary. In short, the State is an all-prevailing, energizing, regulating, far-seeing organization of the people; the culminating expression of the modern democracy. It is this machinery, which in our day is very closely connected with the appliances of modern science, which is not free from the church, but which the church assumes still to direct. Instead, we claim that it is the right and duty of the State itself to look after its own interests, and especially its highest interests, and to take measures to qualify citizens not only to read their ballots, but to discharge all the duties of high citizenship. There is no limit to this duty short of the necessity of the State, as has already been admitted. That which constitutes a State—"high-minded men"—is its necessity, and that it is the duty of the State to provide, to the end that its multifarious industry may be under the guide of the highest statesmanship.

THE French Government has appointed a committee, presided over by Rear Admiral Bourgeois, to study the different applications of electricity to navigation.

THE Society of Telegraph Engineers and Electricians will hold a meeting in Paris on September 21.

MAGIC MIRRORS*.

BY M. BERTIN.

[Translated from the French by Marchioness Clara Lanza.]

LADIES AND GENTLEMEN:—The term Magic was formerly applied to those metallic mirrors employed by sorcerers, necromancers, astrologers and charlatans, and by means of which spirits were invoked and the future predicted. These mirrors, transmitted from antiquity to the middle ages, were used to a very great extent about the sixteenth century, and up to two hundred years ago they were constantly seen in Europe. Now they are found nowhere except in the far East. We are able to furnish any amount of information about this strange superstition, but it is not of these mirrors that I intend to speak.

There is another kind of magic mirror, so-called because it produces effects apparently marvelous but real. History will tell you nothing, however, about these mirrors, and they are not even mentioned in any book of physics. Their appearance in Europe is quite recent, and as they are exceedingly rare, there is not often an opportunity presented for observing them. It is of this scientific curiosity that I shall talk to you this evening.

These mirrors are an uncommon variety of metallic ones. The latter you know were the first invented by man. The Greeks and Romans had no other kind, except a few specimens of glass mirrors made at the factory in Sidon. But glass when not quicksilvered does not make a good mirror, and it was not until the thirteenth century that quicksilver was employed for the purpose. Up to that date metallic mirrors alone were used, and even now some uncivilized nations employ and manufacture no other kind.

The Chinese and Japanese, for instance, are an example†. Since they have been in constant communication with European nations, however, they have partially adopted our glass mirrors and send us their metal ones as objects of curiosity. Chinese mirrors are exceedingly rare, so rare, in fact, that there is not one to be had in Paris. This leads me to think that they are no longer manufactured. Japanese mirrors, on the contrary, are very common. This is perhaps owing to the fact that in Japan the mirror is not only a necessary article for the toilet, but also an object of national worship. The primitive religion of the country, which is still embraced by the aristocracy and called *Synthism*, worships the goddess of the sun as its principal divinity, and the Emperors of the nation are supposed to be her descendants. This goddess invented the metallic mirror, and presenting it to her son bade him preserve it religiously. In the palace of Mikado, therefore, the mirror chamber is as carefully attended to as that of the Emperor himself, and often receives greater attention. In the temples of *Synthism* the only object of worship is a mirror, kept in a box covered with several wrappings of silk. Although this religion has been abandoned by the greater portion of the people, who have since become Buddhists, the mirror, nevertheless, has always remained a precious article. The ladies keep it raised upon a tall easel, which brings the glass upon a level with their eyes when they stand upon tip-toe. When they wish to remove it they hold it carefully by the handle, sometimes thrusting the latter into a piece of split bamboo.

These mirrors are of bronze of various sizes and shapes, but always portable. One side is polished and amalgamated. It is also generally convex, so that the images reflected look somewhat distorted. The other side is flat or slightly concave and is always ornamented by figures

* A lecture delivered before the *Association Scientifique de France*.

† This statement is not altogether correct. The Chinese manufacture glass mirrors, and very seldom, if ever, use metallic ones any more.