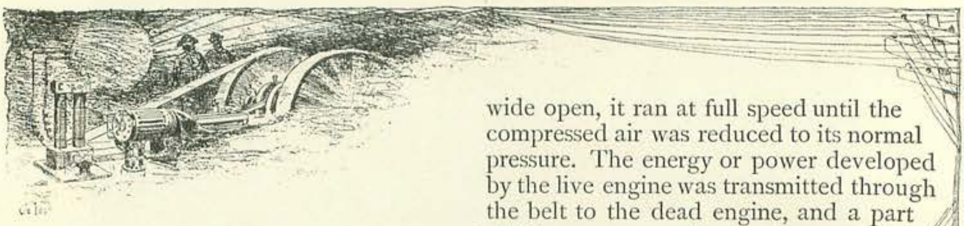
the north of the church — formerly the archbishop's garden, but now open and turfed around the relics of the shattered palace — and see the chapter-house, the "Five Sisters," and the central tower. Whatever may be thought of its interior, no chapter-house is so beautiful as this outside, with its well-designed buttresses and lofty roof and the great elbow of its vestibule. Nor could it be better supported than by the simple aspiring lines of the transept windows and the massive bulk of the tower behind them. Seen from the east the chapter-house forms part of another admirable composition, where it stands in contrast to the long reach of the two-storied choir broken by the vast height of the window in the minor transept. The east-front of the church is typically English and good of its kind, though not to be compared with those produced in earlier days when windows were smaller but more numerous. The immense fields of glass that later Gothic builders used are of course less happy in effect outside a church than inside.

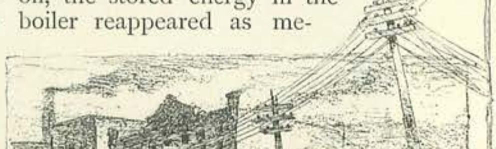
M. G. van Rensselaer.

SOMETHING ELECTRICITY IS DOING.



SEVERAL years ago, at one of the exhibitions of the Massachusetts Charitable Mechanic Association in Boston, there was a display of small steam engines, many of which were supplied with steam and were in motion. One exhibitor, who had a portable boiler with engine attached, did not use the steam supplied to the others, and his exhibit would have been "dead," or idle, had he not put a belt from a neighboring engine to his own. Most of the spectators did not notice this device, and imagined the engine was really at work on its own account. At the hour for closing the hall, when all the steam was shut off and the various engines came to rest, the belt to the "dead" engine was thrown off, and, to the amazement of those present, the idle engine instantly started off and ran at full speed for several minutes before it slowed down and stopped.

The dead engine at work was an example of what is called the "conversion or transmission of energy." The engine was connected with an air-tight boiler, and when set in motion by means of the belt it acted as a compressor and filled the boiler with air under pressure. When released, it became itself a prime mover or motor under the pressure of the air stored in the boiler. The throttle being wide open, it ran at full speed until the compressed air was reduced to its normal pressure. The energy or power developed by the live engine was transmitted through the belt to the dead engine, and a part of this energy was for the time stored in the air within the boiler. When the supply of energy was cut off, the stored energy in the boiler reappeared as mechanical power on the previously dead engine.



It is a curious fact that at the International Exhibition at Vienna, in 1873, a parallel phenomenon was observed. There was at the Vienna Exhibition a display of dynamos of the Gramme type, or, as they were then called, "Gramme machines," and in this exhibit one

of the machines had been connected with an engine and was at work, while a second machine, that stood near it, was at rest. Desiring to show both machines in motion, H. Hippolyte Fontaine, who was in charge of the Gramme display, conceived the idea of joining the two by some suitable conductor. As far as can be learned two dynamos had never been joined, and it was not known what would be the result. By using a long cable, borrowed from a neighboring exhibiter, he coupled the dynamos, and to his surprise the second or dead dynamo started off at full speed. Now it happened that the cable was a long one, and M. Fontaine's device practically demonstrated the conversion of energy and its transmission to a distance. The two dynamos stood side by side, yet, if the conductor had been stretched out in a straight line, they would have been two kilometers apart, and thus the energy transmitted from the engine to the first dynamo practically reappeared as mechanical power two kilometers distant.

Civilization and the safety of governments depend to-day on "motive power." Without cheap and abundant power it is doubtful if the people could be fed and clothed. We practically live on the steam engine and the economic use of its power; and the power we obtain from other prime movers, the turbine, the windmill, the gas engine, the dynamo, and the horse, is of the highest commercial and industrial importance. Of our prime movers or sources of power, the horse, while giving a high efficiency for the food he consumes, is the least valuable, because his power is comparatively small and is only useful for a few hours out of every twenty-four. Windmills, as they are now made in this country, give good results, but at best they are unreliable and of small power. The gas engine and its relative, the hot-air engine, give moderate powers and find a useful field of work in all our large cities. The turbine is efficient and cheap, and is very largely used wherever there is water-power. The steam engine is, so far, the best motor we have, because, while it is theoretically wasteful, it can be operated anywhere on land or sea. This problem of conversion and transmission of energy, therefore, is mainly based on the turbine and the steam engine. They convert the energy stored up by nature and make it available as useful motive power.

Every year it becomes more and more important that we shall be able to convey the power developed by these two prime movers to the work we wish performed. Hitherto we have carried the work to the motor. We can no longer do this at a profit, and the power must be conveyed to the work. The price of land in cities compels us to erect very tall buildings and to use power on every floor. The subdivision of labor and the specialization of manufactures make it more and more important that motive power be divided into very small fractions. We want single horse-powers and even one-tenth or one-eighth horse-powers with variable speeds, and under as complete control as gas or water. Moreover, there is a tendency to return to the old idea of small shops, with one or two artisans in each, for the production of those more or less artistic articles that demand both skill and power. Domestic life, particularly in cities, calls for motive power to run elevators, lift water, and to move sewing-machines and laundry machinery. A city apartment house can no longer be operated without power of some kind. This rapidly growing demand for small powers is evident in the great number of small steam, gas, and water motors now on the market. They are simply the result of the demand. Social science and humanity are deeply concerned in this matter, and, while they may not know it as yet, they should earnestly consider the subject if the evils of the factory system and tenement house labor are to be abated. The truest charity should consider whether it may not be possible to reduce the crowding and misery of our manufacturing centers by changing our system of transmitting energy as well as by trying to improve the factories and tenements. Instead of helping people in the factory, may it not be wiser to carry the motive power round which they are huddled to some other place with happier and more healthful surroundings?

These things are perhaps elementary, yet they are essential to a right understanding of the new method of converting energy now placed before our commercial and industrial communities. Two methods of distributing energy are already in use. One plan is to multiply small motors, to use one engine for one machine or for one very small group of machines. By this plan the stored energy of coal is transmitted through the streets (or gas-pipes) to each little motor. This method, while in general use, is too expensive. The more we multiply steam engines the higher the cost of the power. Twenty five-horse-power engines are proportionally far more costly to build and operate than one one-hundred-horse-power engine. The second method of distribution is by belts and shafting, which includes gearing. This system is necessarily limited in range. Power cannot be distributed by belts (as by cable) for more than two or three miles, and for moving machinery not over a few hundred feet, or more than the height of an ordinary factory. Shafting is limited to perhaps half a block. With both belts and shafts there must be heavy and massive construction to secure the alignment of the shafting and to prevent waste of power through unnecessary motions, jarring, or shaking of the building or machinery. Both are also wasteful by reason of friction. Power can also be transmitted by means of water or air in pipes, but both hydraulic and pneumatic distribution are expensive and wasteful.

It is now thought that Fontaine's experiment at Vienna offers the key to the ultimate solution of this question. Previous to 1873 there had been, all through the earlier years of this century, many attempts to use electricity as a source of power. It had been known that electricity could be used to induce magnetism, and that magnetism could be converted into useful power. From the researches in this field had come many forms of electro-magnetic motors. By a rapid evolution from the crude to the perfect these motors advanced until they promised to be of real value, but they were hampered by one almost fatal defect—expense. As converters of energy they were dependent on a battery as a source of supply, and it was simply "not good business" to burn zinc at seven cents a pound when, with the steam engine, we could burn coal at one-fourth of a cent a pound. With the invention of the Gramme machine and the many forms of dynamos that immediately followed it the question assumed a wholly new phase.

The dynamo, stripped of its technical details, is a machine for transforming energy. It converts mechanical power into that phase or manifestation of energy which we call electricity. Mechanical power is cheap and the dynamo made electricity cheap. The moment electricity was reduced in cost the electric motor assumed a commercial value. It ceased to be a mere laboratory apparatus and became a practical machine for converting electrical energy back into mechanical power. It is not easy to comprehend the immense importance of this latest evolution of machines and all that it means when we say that we have now joined the steam engine, the dynamo, and the motor in one. It is as great an improvement as the invention of the steam engine itself. It is not necessary here to enter into the study of the electric motor as a machine. The point to consider is the position of the electric motor as a transformer of energy and its place in the arts, business, transportation, and manufactures.

Electric motors are now a regular trade product and can be bought, in a variety of styles and shapes, ready made, precisely as we may buy a steam engine or a turbine. They are made in a number of sizes, ranging from one-tenth of a horse-power upward. A motor of one-eighth horse-power weighs only fifteen pounds, and measures $7\frac{1}{2} \times 5 \times 3$ inches. It can be placed in any position, right side up, upside down, or affixed sidewise to a wall, and will deliver power from its pulley in any required direction. Larger motors occupy more space in proportion, but any motor, whatever its size, can be placed in any position where it rests firmly on its base. An electric motor will operate in any ordinary temperature and in any climate, provided it is kept dry. It is practically cold; that is, it gives out no injurious heat while at work. Even when running at very high speed it is safer, so far as mechanical injury is concerned, than any other form of machine or motor. Of its two chief points, the magnets and the armature, only the latter is subject to wear and tear, and this wear is confined to the bearings. The energy passing through the magnets appears, so far as our senses show us, to have no effect on the material of the magnets, and they remain practically unchanged through years of service. When not at work the motor is at complete rest, and all cost of maintenance ceases, except the interest and the slight cost of keeping such enduring metals as copper and iron from injury by rust or fire. Added to these advantages is the fact that the electric motor receives its supply of energy through a wire.

It is difficult at first to comprehend how much is meant by these simple statements. First we may observe the structure of buildings where power is used. In such buildings the walls and floors must be strong and stiff to resist the jarring and weight of heavy engines and to keep the shafting in line so that all points of bearing and strains shall be firm and not wasteful of power by unnecessary friction. With the electric motor, particularly if the power is subdivided among a number of small motors, lighter and cheaper buildings can be used. In place of one large engine in the basement, with belts and shafting to the upper floors, the engine may be in another building, perhaps a mile away, and the dynamo may transmit its energy through wires branching to every floor or to a hundred motors on one floor. With the electric motor it will be possible to erect, as we must, very tall buildings and have "power to let" on every floor. This will not only cheapen the cost of buildings, but enhance the value of real estate by making it possible to put many power-using tenants under one roof.

When the present system of manufactures began in the early part of this century the great mills and factories clustered round the water-powers. Holyoke, Lawrence, and Manchester grew up beside their turbines, and it was the waterfall that settled the value of real estate in our manufacturing towns. With the improvements in the steam engine and the locomotive there came a change to the commercially more convenient cities. The manufactures left the small towns by the rivers and gathered in the cities, and to-day we find Philadelphia and New York are the great manufacturing centers. The factory must stand near its turbine or engine, whether that is the cheapest, the safest, and best place or not. It is safe to say that the electric motor will produce as great a change as ever was seen before, because it is now possible to erect the motive-power plant in one place and the manufacturing plant in an entirely separate one. Many interesting industrial and even social questions at once arise. The position of the engine may be low or wet, near a canal or a noisy railroad yard, in an unhealthy or a morally "infected district," alike injurious to the goods manufactured and to the workpeople who make them. Cheaper, drier, safer, and pleasanter sites may be only a few hundred feet away, and yet by our present system the factory hands, men, women, and little children, must huddle together in a physical or moral swamp in order to be near the motive power on which their work and wages depend. It is the same with the turbine. It must stand at the foot of its waterfall, and the factory must be built on massive and costly foundations immediately above it. Perhaps not a thousand yards away cheap, dry land is idle, simply because we have no mechanical means of transmitting power to such a distance. A wire may be laid anywhere, underground, over valleys and streets, and through walls, and the turbine may be left alone in its well and the engine remain by its coal-yard. The electric motor makes it possible to remove the factory far from its motive power at a material gain to all concerned.

This is not by any means a profitless speculation concerning the far future. It is simply a question of comparative values. The problem now being considered in all our industries is the cost of the conversion of energy. The cost of motive power at the engine or turbine is well known. Can that power be conveyed to other places at a profit? Will cheaper construction, cheaper, better, and more healthful land, and greater safety and convenience, pay for the necessary loss of power in conversion by means of motors? There are three conversions with the electric motor, and each entails a loss of power and thus of money. From reliable data it appears that there is a loss of about nine per cent. between the prime mover and the dynamo. That is, the dynamo receiving 100 horse-power from its prime mover delivers to the conductor only 91 horse-power; the conductor, a mile long, also entails a loss and delivers to the motor only 81 horse-power; the motor, one mile from the engine, entails a further loss, so that finally only 71 horse-power is delivered to the machinery. The great commercial and industrial problem before us is to settle how far this loss of power in conversion may be offset by cheaper buildings, cheaper land, and lower rents. There is every reason to think that in many places, notably in Boston and New York, the question has been settled in favor of the motor. It must also be observed that with our present system of mechanical conversion by belts and shafts there is a loss in transmission, and the question is, which is cheaper, the single loss of friction by mechanical transmission, or the three losses by the motor? There can be no doubt that for all distances beyond a very few hundred feet the motor is the cheaper. This, at least, seems to be settled: the motor is cheapest the moment the factors of construction, land values, sanitary safety, and security from flood and fire are taken as real parts of the problem. The cable road indeed conveys power for a mile or more by means of its traveling-belt, yet it is enormously wasteful. The larger part of the power must be consumed in moving the cable, and every turn at street corners involves a loss of power. With a wire there is, so far as can be detected, no loss whatever by bending the wire at a right angle. To all this we must add in favor of the motor complete escape from the heat, noise, dust and ashes, and danger from fire that must always accompany the steam-power plant. By far the larger part of the fire losses in manufactures of all kinds springs from fires started by the boilers. With the motor the factory may be removed to a safe distance from all danger. The boiler-house may burn, but the mill need no longer go with it.

To the student of social science the electric motor is full of suggestions for the future. If power can be subdivided and conveyed to a distance, why may not our present factory system of labor be ultimately completely changed? People are huddled together under one roof because belts and shafts are so pitiably short. If power may traverse a wire, why not take the power to the people's homes, or to smaller and more healthful shops in pleasanter places? To-day we find sewing-women crowded into a hot, stuffy room, close to the noise, smell, dust, and terrible heat of some little steam engine at one end of the room. The place must be on a low floor because of the weight of the engine and the cost of carrying coal upstairs. Let us see how the work may be done with motors. We may take the elevator in a wholesale clothing warehouse on Bleecker street and pass through the salesrooms to the top floor. The building is lofty and of light construction, and yet we find in the bright and pleasant attic above the house-tops a hundred girls, each using power. They are seated at long tables, each one having a sewing-machine, and secured to the under side of the table is a small electric motor, one to each machine. The operator has only to touch a foot-pedal and the motor starts, giving about one-tenth of a horse-power, at very high speed. If the speed is too fast it can be regulated at will by the pressure of the foot on the treadle. There is no heat, no dust or ill-smelling oil, and only a slight humming sound, the sewing-machine itself making more noise than the motor. The room is sweet, clean, and light, and it is in every respect a healthful workroom. If we look out of the window we see two insulated wires passing under the sash down to the electric-light wires on the poles below. There are people who cry out against the overhead wires, and would pull them all down. Some day they will be buried underground. Meanwhile, is it not an immense gain for these working-girls to be placed in a quiet, sunny room, far from the maddening engine? In another shop on Broadway we may see a different arrangement. A two-horse-power motor takes its current from an electric-light wire in the street, and redistributes its power to shafting placed under the work-tables. Each operator with a touch of the foot throws her machine into gear, and takes her share of the two-horse-power.

In like manner it is possible to go to many places in all our cities and find motors of all sizes doing useful work in converting the energy flowing in the street wires into power for driving printing-presses, circular saws, elevators, pumps, ventilating-fans, and machinery of every kind. It is not so much a question as to what the motor will do as of the convenience of reaching an electric-light wire in the street. It is safe to say that to-day there is not a single building being put up for small manufacturing plants where "Power to let" is to be painted on the door that is not considering the question between engines and motors. One large building now going up in New York, and intended to be let out with power in small shops on every floor, has no provision whatever for shafts or belts. The engine and dynamos will be placed in the basement and wires laid in the walls to small motors placed on every floor. Moreover, there being an excess of steam power, the wires will also be laid to other buildings within a radius of half a mile in every direction. The saving in construction and insurance, and the gain in cleanliness, quiet, safety, and healthfulness in that neighborhood, will be difficult to measure in dollars and cents.

In mountainous districts, where it is difficult to transport steam engines and where water-power is often cheap and abundant, the electric motor appears to open a remarkable future to our mining interests. The introduction of motors at Big Bend on the Feather River, Butte County, California, may hint at this future by showing what has already been done. At this place turbines drive dynamos, supplying a current that travels through a circuit of eighteen miles, and at fourteen points alone the line motors are used to drive pumps and hoisting machinery, and by branch wires the power can be used a mile on either side of the main circuit. This is only one instance of what is being done and may be done for the transmission of energy in our mining districts.

One of the most curious things in the behavior of electricity is the fact that a current will flow from one conductor to another if they merely touch each other, and even if the point of contact is continually changing. Thus we may have a "rolling contact," as when a wheel rolls along a wire. This simple fact is the foundation of the entire system of electric railroads. The first experimental use of motors to move a car proved that it is possible to convey energy through a wire to a motor traveling on a track, and so conclusive were these first experiments that throughout the world attention was at once called to the subject of electric railroads. Several of the earlier plants are still in use, though they are, in point of mechanical construction, far inferior to those now being laid in this country. Once brought to a reasonably practical position, the electric railroad is accepted to-day almost instantly. A year ago there was opened the first long and difficult electric road, at Richmond, Virginia. To-day there are at least fifty roads in operation — perhaps the most remarkably rapid commercial application of a new system ever seen. Twenty-five years ago the people were not educated to such instant acceptance of a wholly new system of transmission of energy. Whether such roads will be cheaper than horse-power remains to be seen. The opinion seems to be, up to this time, that the motor, if not now, will ultimately be the cheaper. If for no other reason than the happy escape from horse-power, the electric car should be welcomed, and is welcomed, by the public as well as the stockholders. The housing of a thousand horses in one building in our cities is unsanitary in the extreme, and if for no other reason than the removal of such a mass of animal life from our city limits the electric car should be insisted upon as the better motor. Compassion alone would demand that any motor that will release us from the daily contact with the car-horse and his miseries should be welcomed.

Another feature of the electric motor is its adaptation to the accumulator, or secondary battery. This battery is now the subject of most earnest study. It practically stores energy and releases it through the motor to move a car or to drive machinery. It would seem as if the battery, like the motor, was destined to produce great changes in our system of power transmission, and already it is at work in our streets moving cars in silence and at good speed. How far it is to supersede the present plan of transmitting the power to the car by means of a wire placed under the track or hung over the car on poles remains to be seen. At present the larger part of the electric roads use a wire in some position near the track.

Within the past ten years there has been a remarkable increase in the number of electric-lighting stations, until they are now to be found in every town of any considerable size in the country. Every electric-light circuit may be also a source of power. Motors adapted to both the arc light and the incandescent light systems can be connected with one or other of these light circuits and draw power instead of light from its wires. Centers of distribution for power are therefore already widely established, and it is now perfectly easy and convenient to obtain power along the line of these light circuits.

Regarded as a machine the electric motor is remarkably efficient, considering the very few years, hardly months, in which it has been manufactured on a commercial scale. Of the half-dozen principal companies manufacturing motors all are of very recent origin, and all report a demand for motors in excess of the facilities for making them. At the same time the motor and its manufacture are practically in their infancy. Even within a few months most interesting and promising improvements are announced that will both increase their power and cheapen the cost of the power they supply.

The electric motor has but one source of danger, and that is the current supplied by the wire. This is no more than the danger from steam-pipes and boilers. Knowing the conditions and limits of safety with steam we use steam everywhere. In like manner, when we learn what are the factors of safety with electricity we shall use it with the same freedom as we use steam. The condition of safety with the motor is perfect insulation, and this is provided for in all motors, so that practically the new motor is as safe as any of the prime movers from which we derive energy for useful work.

Charles Barnard.

LOVE'S UNREST.

THOU lovest me. I am a woman, so
I loved thee whom I liked before I loved;
For love creates itself, and therefore love
Is God. . . . Come, lover mine, and sit you down;
There at my feet I 'll teach you how to love.

Take first my hand, as one who plucks a flower
To love it, not to crush it in his hold —
Oh, fie! Think you a tender flower could bear
So fierce a pressure, stupid that you are?
Poor flower! See, now, thou hast a rosier hue
Given to its petals. Nay, thou shalt not have
It more. . . . Where was I? How can I proceed
If thou hast not my hand? There, take it then,
But yet, forget not it is but a flower.

Now look at me. . . . Nay, turn thine eyes away —
I — do not like their gaze — I — I forgot
To say 't is better thou shouldst often look
Another way, that thou mayst scan thyself
To understand if truly thou dost love!
And to this end I 'll question thee. Dost think
Of me at morn and eve, and ever with
The self-same love, and love and naught but love?

Nay, turn away thine eyes! . . . And dost thou know
That love for me will ever be as now,
When I am old and wrinkled, weak perchance?
Say naught. If ever thou dost love no more,
My love will die as it had never been;
For my love hangs on thine as bee on flower,
Who, when the honey-cup is void, hums off
To gather more — or die — as it may be.

. . . .

Look back at me, O lover mine! and say,
"I love thee," o'er and o'er. My heart is full
Of saddened thoughts that I myself have wooed.
The bee not thus would turn his honeyed wine
To bitter,— nor will I! I do believe
Thou truly lovest me, as — I love thee.

L. M. S.