wheels, fitted with compensating motion to its drivers, to enable it to turn very sharp corners with facility. It is also driven and steered by one man. Crane engines similar to this, and built by the same firm, were used at the Vienna Exposition during the erection of the building, and did a vast amount of excellent work in unloading and removing the heavy packages of merchandize as they a rived on the grounds.

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Contents:

(Illustrated articles are marked with an asterisk.)

PRESSURE NOT A MOTIVE POWER.

The error of confounding mere pressure with energy available to produce power is the main origin of the majority of attempts at perpetual motion, and even sometimes causes, among confused minds, exaggerated expectations about the effects to be obtained from mechanical contrivances.

We consider the alleged discovery or invention of Mr. Keely, described on page 273 of our current volume, to be a case of the latter class. He is said to develope, by means which he carefully keeps secret, a gas under enormous pressure; and by the exhibition of this pressure, he has induced a few engineers (who should know better) to testify not only in regard to what they see, but to make inferences as to the enormous power to be expected from such an exhibition. They forget that this pressure cannot be utilized without letting it off; and that the great problem in producing motive power is not simply to originate a great pressure, but to generate it abundantly, cheaply, and as fast as it is consumed in the production of motion.

Fifty tuns weight supported by three small blocks of one cubic inch each, will exert on each a pressure of some 33,000 pounds to the square inch; but this mere pressure of 33,000 pounds is not a horse power; it only becomes so if we cause the 33,000 pounds to descend one foot per minute, and if, at the end of this descent, it can only be restored by lifting the weight back to its original hight.

A wound-up spring is perfectly equivalent to a weight; it may exert a certain pressure, large in proportion to its size and strength; but unless it is allowed to unwind, it cannot produce motion or power; and the exhibition of a spring pressing with a power of 12,000 pounds on one square inch of material does not prove the possession of a principle of motive power, unless we can wind up the spring as fast as the power is expended.

It is the same with compressed air or gases; they are in fact nothing but wound-up springs: with the difference, however, that, in place of needing mechanical power to wind them up, we may use, for their development under confinement and consequent pressure, either heat, chemical agencies, or electricity.

The steam and hot air engines are illustrations of of the first case; expenditure of heat keeps up a continuous generation of steam from water, supplying the loss as fast as necessary; or it expands confined air continually, and so increases the pressure which, when moving the engine, is necessarily released. The chemical fire engine and the so called fire annihilators are illustrations of the second class; the action of an acid on a carbonate (both in water, but kept separate until needed) developes carbonic acid gas, which is set free with such energy that the water may be forcibly ejected with the gas and made useful as a ready substitute for a fire engine.

The pressure which it is possible to generate in this way is something enormous, and has more than once given rise to serious accidents by the explosion, or rather the bursting, of the vessel in which the pressure was generated. It is now twenty years since Natterer, of Vienna, with a very powerful condensing apparatus constructed on the same principles, attempted to liquefy the four gases which thus far have resisted all attempts at liquefaction, namely, nitrogen, oxygen, hydrogen, and oxide of carbon; but he did not succeed, notwithstanding that he carried the pressure to nearly 3,000 at mospheres, or 45,000 pounds to the square inch.

It is indeed surprising to notice the apparently irresistible force exerted by the molecules of bodies, when (induced by cold, heat, chemical action, or electric agency) the component particles are compelled to adopt another molecular arrangement. The expansion of freezing water may burst the heaviest bombshells; that of steam, the strongest boilers; the development of gas by chemical agency may overcome any power with which we may oppose it by attempting its confinement. It is the same with electricity, which, subtle as the agent is, will, when its current induces the change of any substance into gases, serve to produce a tremendous pressure within the walls of the vessel containing the substance. This method, we anticipate, will yet prove available for investigations on the behavior of divers substances under pressures, surpassing even those of Natterer. For such experiments the water to be decomposed is to be confined in a sufficiently strong vessel, in which are also the electrodes conducting the decomposing electric current.

As, in the invention of Mr. Keely, the heat and chemical action are said to be excluded, the only other agent which appears to be left is electricity, and we therefore suspect that the alleged enormous power, from the electric forces included in a drop of water, is in fact nothing but the enormous pressure of the gas developed, from water under confinement, by a galvanic current, or the induced current from a magneto-electric machine, driven by mechanical power. The pretence that the pressure is developed by a mechanical device, requiring little power, may be true, but that the power obtained from the pressure can possibly surpass that of the power employed is absurd and its application to motive power is simply a phantom.

GOVERNORS FOR PRIME MOVERS.

The use of a governor is to preserve a perfectly regular speed in the engine, water wheel, or other prime mover to which it is attached, by varying the supply of steam, water, or other motor, as the work of the machine varies. The ordinary form of fly-ball governor answers its purpose very well in most cases. It has the defect, however, of requiring the use of heavy balls, and of demanding a somewhat wide range of action where it has any considerable force to overcome. It also is not perfectly isochronous, that is, it will not compel the engine to "come to speed" with precision, under all variations of load and steam pressure. The Porter governor, in which the balls are loaded down by a heavy weight on the spindle, and which is thus enabled to run at a much higher speed, is a modification of the standard form, and is prompt in action and much more powerful. These are the advantages which have brought it into use so extensively in Europe. In this country, the Pickering governor, in which the same object is accomplished by carrying the balls on stiff steel springs, has come into use quite largely as possessing similar advantages.

The only isochronous governors which are used to any extent in the United States are the Huntoon governor and its modifications, in which a screw, rapidly rotating in a closed tank containing oil or water, exerts a force in the line of its axis which is made use of in operating the throttle valve. While the engine is at speed, no movement of the valve occurs; but should the speed diminish, a weighted arm forces back the screw, and the valve opens. It will continue to open until the engine comes up to the proper speed again, whatever the conditions as to the load or steam pressure. Should the speed exceed that intended, the screw acts more energetically upon the liquid in which it works, and the increased effort is sufficient to overcome the resistance of the weighted arm and to close the valve until the proper speed is again acquired. In Europe, the same object is accomplished by some builders by the use of the parabolic governor, which is so arranged that the balls move in a parabolic instead of a circular arc. It can be shown by a mathematical argument, which cannot be given here, that this produces the effect of isochronism: that the governor will remain without affecting the throttle valve at only one speed, the one for which it has been proportioned and speeded. The late Professor Rankine invented a very neat governor of this class, which is perfectly isochronous.

In a friction governor invented by Professor Thurston, and designed by one of his pupils, the same result is attained by making use of the varying friction of blocks pressed against a drum by centrifugal force. When above or below speed, the valve is compelled to move in the proper direction until the engine is brought to speed, or until the valve has been either entirely closed, or is wide open. Siemens' governor is also a friction governor, but somewhat different from the latter in its general arrangement, and entirely different in details. The Pitcher hydraulic regulator, which was much used some years ago on engines fitted with the Sickles cut-off valve gear, was a pump which forced water into a chamber, having an orifice fitted with a plug which was capable of adjustment to give any desired size of opening. Above the chamber, and communicating with it, was a pump plunger connected with a throttle valve. When the engine ran above speed, the orifice was not of sufficient capacity to discharge the water as fast as it was pumped into the chamber, and the second plunger was forced up, closing the throttle valve. When the speed was less than that proposed, the water issued from the chamber more rapidly than it was forced in, and the plunger, which was attached to the throttle, fell, opening the valve. This was another of the isochronous class of governors.

None of these regulators have sufficient power to overcome any serious resistance or to act through any considerable distance. Water wheel regulators, consequently, are usually of a different construction from those above described. In the best of the common forms, the fly ball governor is employed to move a clutch which engages a train of gearing driven by the water wheel, and puts it in motion in one direction or the other, as the opening or closing of the gate to which it is connected is necessary.

Hundreds of patents have been issued to invento s of various forms of governors, in which it has been attempted combine sensitiveness, isochronism, and strength of action, but the problem still remains unsolved. What is wanted is a device which, while combining these three requisites of a good regulator, shall also combine the requisites for commercial success, strength, durability, simplicity, and, above all, cheapness. Many of our best mechanics have tried to produce such a governor and have failed, but we cannot suppose the object aimed at entirely unattainable.

It will be remembered that our special Vienna correspondent described the next best form of steam engine to our standard drop cut off engine as a plain, neat, beautifully proportioned, and well finished English engine, having a plain three-ported slide valve, with the Meyer expansion valve riding on the back of the main valve—just such an engine as is sold in New York by the agents of some of our best builders. This valve gear is well fitted to produce a sharp cut-off and an excellent distribution of steam. The point of cut-off must, however, be adjusted by hand, and the governor attached to a throttle valve in the steam pipe, because this work is too heavy to be done by the governor without entire loss of its sensitiveness and efficiency.

Putting the throttle valve in the steam pipe, as a regulating valve, is always avoided, if possible, by good engineers, because, by throttling the steam, a loss of efficiency occurs. It is always preferred to regulate the engine by so attaching the governor that, as in the best drop cut-off engines, it shall determine the point of cut-off. We gave the reasons for this preference in our issue of May 23, on page 321 of our current volume. The invention of such a governor, which we have described as one of the wants of the time, would enable this simplest, and in other respects most satisfactory, style of engine to compete with the most expensive forms in the market in perfection of regulation and in economy of steam. It would thus confer a great benefit upon steam users and, consequently, a great pecuniary reward upon the inventor. Such a governor would find many other applications, and would displace, not only the ordinary steam engine governor, but, in many instances, it would probably take the place of the water wheel or disengagement governor.

WHY DO PLANTS ABSORB OXYGEN DURING THE NIGHT?

When a number of freshly gathered and healthy leaves are placed during the night under a bell glass of atmospheric air, they condense a portion of the oxygen; the volume of the air diminishes, and there is a quantity of free carbonic acid formed, generally less than the volume of oxygen which has disappeared. If the leaves which have absorbed this oxygen during their stay in the dark be now exposed to the sun's light, they restore it nearly in equal quantity, so that, all corrections made, the atmosphere of the bell glass returns to its original composition and volume.

Leaves in general have the same effect when they are placed alternately in the light and in the dark there is however a very obvious difference in the intensity with which the phenomenon is produced, according to the nature of the leaves. The quantity of carbonic acid formed during the night is so much the less, as the leaves are more fleshy, thicker, and therefore more watery. The green matter of fleshy leaved plants, of the *cactus opuntia*, to quote a particular instance, does not produce any sensible quantity of carbonic acid in the dark: but these leaves condense oxygen and exhale it again like those which are less fleshy when they are brought into the sun, after having been kept for some time in the dark. De Saussure applied the names of inspiration and expiration of plants to these alternate effects being led by the analogy—somewhat remote, it must be confessed—which the phenomenon presents with the respiration of animals.

The inspiration of leaves has certain limits; in prolonging their stay in the dark, the absorption becomes less and less; it ceases entirely when the leaves have condensed about their own volume of oxygen gas. And let it not be supposed that the nocturnal inspiration of leaves is the consequence of a merely mechanical action, comparable, for example, to that exerted by porous substances generally upon gases. The proof that it is not so is supplied by the fact that the same effects do not follow when leaves are immersed in carbonic acid, hydrogen, or nitrogen. In such circumstances, there is no