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 tons 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 atmospheres, 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 Viénna 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

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appreciable diminution of the atmosphere which surrounds the plant. The primary cause of the inspiration of oxygen by the leaves of living plants is, therefore, of a chemical nature. With the facts which have just been announced before us, it seems very probable that, during the nocturnal inspiration, the carbonic acid which appears is formed at the cost of carbon contained in the leaves, and that this acid is retained either wholly or in part, in proportion as the parenchyma of the leaf is more or less plentifully provided with water.

A plant that remains permanently in a dark place, exposed to the open air, loses carbon incessantly; the oxygen of the atmosphere then exerts an action that only terminates with the life of the plant: a result which is apparently in opposition to what takes place in an atmosphere of limited extent. But it is so, because in the free air the green parts of vegetables can never become entirely saturated with carbonic acid, inasmuch as there is a ceaseless interchange going on between this gas, and the mass of the surrounding atmosphere; there is, then, incessant penetration of the gases,as it is called. There is a kind of slow combustion of the carbon of a plant which is abstracted from the reparative influence of the light.

The oxygen of the air also acts, but much less energetically, upon the organs of plants that do not possess a green color.

The roots buried in the ground are still subjected to the action of this gas. It is indeed well known that, to do their office properly, the soil must be soft and permeable, whence the repeated hoeings and turnings of the soil, and the pains that are taken to give access to the air into the ground in so many of the operations of agriculture. The roots that penetrate to a great depth, such as those of many trees, are no less dependent on the same thing; the moisture that reaches them from without brings them the oxygen, in solution, which they require for their development. It is long since Dr. Stephen Hales showed that the interstices of vegetable earth still contained air mingled with a very considerable proportion of oxygen. The roots of vegetables, moreover, appear generally to be stronger and more numerous as they are nearer the surface. In tropical countries, various plants have creeping roots which often acquire dimensions little short of those of the trunk they feed.

If a root detached from the stem be introduced under a bell glass full of oxygen gas, the volume of the gas diminishes, carbonic acid is found, of which a portion only mingles with the gas of the receiver, a certain quantity being retained by the moisture of the root.

The volume of the gas thus retained is always less than that of the root itself, however long the experiment may be continued. In these circumstances, whether in the shade or in the sun, roots act precisely as leaves do when kept in the dark. Roots still connected with their stems give somewhat different results.

When the experiment is made with the stem and the leaves in the free air, while the roots are in a limited atmosphere of oxygen, they then absorb several times their own volume of this gas. This is because the carbonic acid formed and absorbed is carried into the general system of the plant, where it is elaborated by the leaves if exposed to the same light, or simply exhaled if the plant be kept in the dark.

The presence of oxygen in the air which has access to the roots is not merely favorable; it is absolutely indispensable to the exercise of their functions. A plant, the stem and leaves of which are in the air,soon dies if its roots are in contact with pure carbonic acid, with hydrogen gas, or nitrogen. The use of oxygen, in the growth of the subterraneous parts of plants, explains why our annual plants, which have largely developed roots, require a friable and loose soil for their advantageous cultivation. This also enables us to understand why trees die when their roots are submerged in stagnant water, and why the effect of submersion in general is less injurious when the water is running, such water always containing more air in solution than that which is stagnant.

MILK AS A DIET AND ITS EFFECT ON THE SYSTEM.

There is considerable difference of opinion on the subject of a milk diet. It is surrounded with a mass of whims, of prejudices, and of mistaken ideas, which are based more on individual fancies than upon certain fact. To one a glass of milk imbibed is believed to be a sure provocation of a bilious attack, to another, a disordered stomach, to a third, drowsiness, and so on, through such a category of simple though disagreeable ailments that we look aghast at the farmer who drains cup after cup of the fresh pure liquid, time and again during the day, and wonder at the resisting powers which his organization must possess. The truth is, however, that milk is not unwholesome. On the contrary, it contains good substantial bone,muscle,flesh,and brain producing substances, which, assimilating, quickly act rapidly in building up the body. Naturally, we assert, it is nourishing; that it does bring on certain troubles is nevertheless true, but the cause is in the individual stomach, not in the milk, provided, of course, the latter be fresh and sweet. The *Commercial Advertiser* of recent date has some excellent remarks on this subject which are well worthy of repetition. "Milk diluted with one third lime water," it is said, "will not cause any one biliousness or headache, and, if taken regularly, will so strengthen the stomach as to banish these disorders.

"It may be taken with acid of some kind when it does not easily digest. The idea that milk must not be eaten with pickles is not an intelligent one, as milk curdles in the stomach nearly as soon as it is swallowed. When milk is constipating, as it is frequently found to be by persons who drink freely of it in the country in summer time,a little salt sprinkled in each glassful will prevent the difficulty. When it has an opposite effect, a few drops of brandy in each goblet of milk will obviate its purgative effect. As milk is so essential to the health of our bodies, it is well to consider when to take it, and how. It is a mistake to drink milk between meals, or with food at the table. In the former case it will destroy the appetite, and in the latter it is never proper to drink anything. After finishing each meal a goblet of pure milk should be drank; and if any one wishes to grow fleshy, a pint taken before retiring at night will soon cover the scrawniest bones. In cases of fever and summer complaint, milk is now given with excellent results. The idea that milk is "feverish" has exploded, and it is now the physician's great reliance in bringing through typhoid patients, or those in too low a state to be nourished by solid food."

Our contemporary, we notice, says that the persons with whom milk does not agree are the very ones who require it, and whom it would probably regenerate, did they so prepare it as to make it palatable and suitable to their particular constitutions. Not exactly, we think. It should be remembered that "what is one man's meat is another man's poison" is a very frequent case; and while, as we have above pointed out, milk may in perhaps a majority of instances be rendered agreeable to the stomach, still there are certain organizations which persistently refuse it in spite of any assisting admixture. A similar illustration may be found in the case of wine; and we know of instances where persons,of otherwise strong digestion, are utterly unable to drink half a gill of even the purest grape juice without experiencing the same bilious and other derangements which many ascribe to milk. It is a fact, however, that for individuals troubled with dyspepsia, weak stomach,and kindred ills, milk has wrought remarkable and unexpected benefit, and the diet has in cases among our own acquaintances resulted in great relief.

Milk drinking, particularly in this city, has during late years received an unusual impetus through the establishment of dairies, or restaurants where the bill of fare is confined to a few simple articles of farinaceous food and to generous bowls of milk and cream, retailed at very moderate prices. The idea, we believe, originated some five years ago in a small baker's shop, in one of the little down town streets, which had a monopoly of the business for some time,making large receipts. Others, being attracted by the gains, embarked in the business, and now the dairy is as much a fixture in New York city as the more pretentious restaurant. As a matter of curiosity, we recently inquired of the manager of the largest of these establishments as to the people who patronize the diet, and the effect of the increased demand upon the supply. His customers,he told us,comprised every class; the rich banker perches on the high stool beside his errand boy. Clergymen, lawyers, merchants, editors, men whose reputation is worldwide, throng into the doors, proving that,even if this sudden increase in milk drinking be merely a popular mania, it is nevertheless one which has affected all alike.

The milk for the city is brought principally from Westchester and Dutchess counties in this State, and the neighboring counties in Connecticut. In the dairy above referred to, the stocks of several large farms are required to produce the necessary amount. Twelve hundred quarts in cool weather, and upwards of eighteen hundred quarts when the mercury makes excursions into the nineties, are daily consumed by an average of twenty-five hundred persons in the single establishment. This milk is sold at about ten cents a quart, realizing a fair profit.

The greater portion of the milk used in the city does not come direct to the seller, but goes through the same handling, by four or five "middle men," as the often doubtful fluid retailed by the peripatetic milkman. The farmer, for instance,binds himself to supply a certain number of cans to the contractor for a definite period, usually six months, at the price of about 33 to 42 cents per can in summer or 45 cents in winter. The contractor receives the filled vessels from a collector, who gathers them from the different farms and deposits them at the railway stations. Under charge of the latter,they are transported in early trains to the city and sold at the depots to milkmen and dairy keepers at an advance of about five cents per can. The milkmen supply families and grocers with the commodity, *plus* another profit which brings its cost to the consumer, as above stated to about ten cents per quart.

As to the quantity of milk daily consumed in New York, it is difficult to obtain any precise figures; but it is estimated that the supply does not fall short of two million quarts every twenty-four hours. This on a rough calculation is the produce of some thirteen thousand cows and an average of something over two quarts *per diem* to every soul of the population.

THE RESPIRATION OF OXYGEN.

According to the older notions in regard to the provision of Nature for the sustenance of life, the surrounding conditions have been expressly arranged for the benefit of all living creatures, so as to secure not only their existence but their welfare and comfort. According to late ideas, however, as the different living creatures were evolved under previously existing conditions, the mode of their development was such as to accommodate the different organisms to these conditions; and when the conditions changed, a corresponding change occurred in the creatures themselves: those not adapted to the changed conditions perishing, and those most fit for the new era surviving and propagating their species. We will illustrate this by an example: In our atmosphere, the oxygen is diluted with very nearly four times its amount of nitrogen, and all the air-breathing animals, including man, have become adapted to these conditions. If the amount of oxygen became less, a corresponding change would occur in the respiratory system, as is illustrated in the high lands of South America, where, by reason of the rarefied atmosphere, the amount of oxygen inhaled at each respiration is less than near the ocean level; and as a consequence, the human lungs are more developed there, and the inhabitants are remarkable for their largely developed chests, allowing them to make up by quantity for the quality of the inspired air. The reverse is also the case; it has been found that the effect of the compressed air (on those workmen whose constitutions allowed them to withstand the pressure and labor for some length of time in the caissons for the foundations of the Mississippi bridge at St. Louis, Mo., and the East river bridge, New York) was to narrow the volume of the chest, while deep respirations of the highly compressed air were painful.

Now comes an interesting discovery of M. P. Bert, who finds that it is not alone the pressure which is hurtful to the system, which can soon accommodate itself to it, but chiefly the concentration of the oxygen, which even acts like a most violent poison when inhaled pure, under a pressure of three or four atmospheres; consequently when (under a pressure of some 90 or more pounds to the square inch) an amount of oxygen surpassing the normal quantity some six or more times is inhaled at every respiration, its hurtful effects manifest themselves, one of them being a very great increase in animal heat, with a disturbed pulse; this, of course,adds largely to the discomfort. This fact suggests that men who have to submit to conditions of greatly increased atmospheric pressure would be relieved and benefitted by inhaling an artificial atmosphere containing less than the normal amount of oxygen, 10 per cent oxygen to 90 of nitrogen for two atmespheres pressure, 5 per cent oxygen and 95 nitrogen for four atmospheres, and so on. The value of this suggestion is strengthened by the French physicist De Fonvielle, who maintains that the discomfort experienced by travelers on high mountain peaks, or by aeronauts when ascending to high altitudes, is not so much caused by the diminished atmospheric pressure as by the want of oxygen, which, in that rarefied condition, is not given to the lungs in sufficient quantity. He suggested, therefore, the inhalation of pure oxygen at those high altitudes; and two balloonists, Sivel and Croce-Spinelli, have verified this theory during a recent ascent in the balloon *Etoile Polaire.* M. Croce-Spinelli, when he had reached a hight of 16,400 feet, experienced a strong feeling of suffocation; he then resorted to the inhalation of pure oxygen (enclosed in a large rubber bag with which he was provided), and became not only relieved, but recovered his normal condition of perfect comfort. The effect on the pulse was remarkable: while below it was 86 beats per minute, it rose, at a hight of 16,000 feet, to 140; when oxygen was respired, it descended at once to 120.

The published account of this ascent adds the following: "When not using the respirator, the skies appeared to the observers quite dark; but when freely respiring the oxygen, the blue color of the heavens was restored." As the blue color of the sky is due to the refraction of the solar light in the atmosphere, it is an objective phenomenon, and cannot be seen at such high altitudes, where there is little of the atmosphere (and that little very rarefied) left above the observer. The statement that the blue color was restored by the inhalation of the oxygen would infer that the hue is subjective and due to the condition of our eyes, induced by breathing the gas.

In regard to the hight which travelers are able to attain, we may state that Alexander von Humboldt, in his ascent of Chimborazo, was compelled to stop at a hight of 16,000 feet, at which point he had to give up from suffocation; but in late years the brothers Schlagintweit ascended the Himalayas, and slept all night in bivouac at a hight of 19,200 feet, and later ascended the peak Ibi Gamin, 22,200 feet high.

The English astronomer Mr. Glaisher claims that he has ascended to a hight of 26,000 feet without feeling any discomfort, and that only when reaching 32,000 feet he experienced any very serious feeling of suffocation. No doubt, different constitutions are differently affected; some are unable to resist diminished atmospheric pressures, others increased pressure. We met even last summer a consumptive individual on Mount Washington (which is not much over 6,000 feet high), who stated that he felt such a feeling of suffocation that he was obliged to hasten down on the same day.

THE AMERICAN SOCIAL SCIENCE CONGRESS.

The American Social Science Congress will hold its annual session in New York city, commencing on May 19 and terminating on May 23. The title of this institution is broad enough to cover a vast field of useful knowledge,and the subjects for investigation are very numerous and interesting. Mr. George W. Curtis will preside, and papers by Rev. Dr. Woolsey on exemption of private property from capture at sea, by Mr. W. C. Flagg on the farmers' movement, by President Gilman on California, by Hon. D. A. Wells on taxation, by Professor Peirce on ocean lanes for steamship navigation, by Mr. G. G. Hubbard on railroads, and by Professor Sumner on the Finance Department, will be read. Many other papers relating to public health, penal institutions, charity, and kindred subjects are promised, and the Boards of Health and Public Charities will probably be in session on the same days.

THE bill before Congress for the grant of national aid to the extent of three millions of dollars in behalf of the Centennial Exhibition has been defeated.

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