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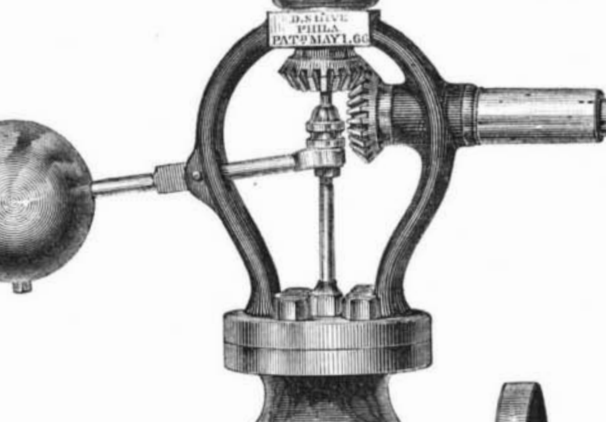
Patent Steam Engine Governor.

The nature of this improvement consists in swinging the balls of a centrifugal governor, at an angle to a radial line, harmonizing with and corresponding to the motion of said balls, in such manner that the inertia, the momentum and centrifugal force, all act in favor of the governor, instead of against it, as is the case in the ordinary centrifugal governor.

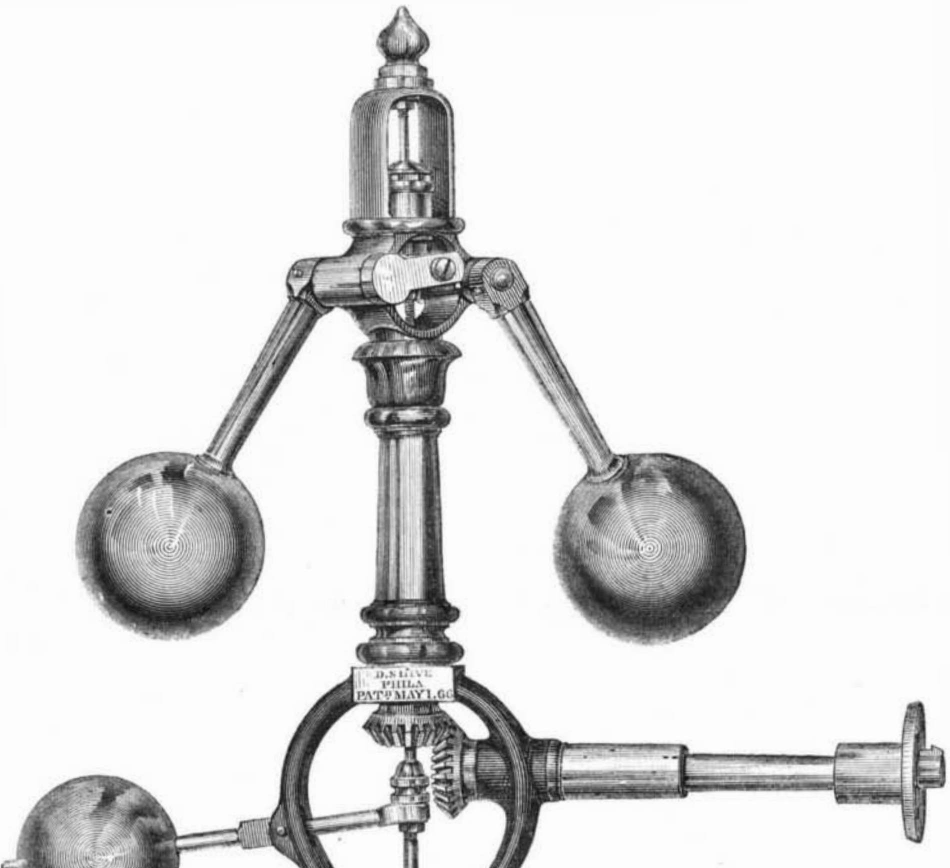
This is illustrated in Fig. 2. A circle, B, is struck, of nearly the size of the ball. A square is then formed by drawing lines tangentially with the circles as shown by dotted lines. This square gives the plan of the governor. C is the point of suspension of the arm; the line from C to D represents the arm, as also the direction of the swing of the ball. The lines from C to E constitute the centers of the pins upon which the arms, F, and links, G, are firmly fixed. The pins connecting, F and G, turn freely in sockets, C E. Links, G, form a connection with a stem passing through the center of the valve. Links, G, may also turn outward, as shown at H, and form a connection with a sliding sleeve. The sockets, C E, are firmly secured to the shaft giving them motion. The angle of the plane in which the balls swing is indicated by the dotted radial line, I. Balls vibrating at this angle will swing freely whether moving quickly or slowly; if moved slowly, they will be acted upon by but little centrifugal force, and will swing low and perfectly free from the point of suspensions; if moved quickly, they will be acted upon by greater centrifugal force, and will swing higher and further out, though quite freely, without causing the least binding or friction at the joints, by which the arms are suspended. The balls are at liberty to fall to the rear of the points of suspension, or to gain upon said points, according as the force of their inertia or their momentum predominates. By this arrangement we obtain a governor the most simple and cheap of construction, beautiful in form, and in action, durability, and efficiency the most complete.

THE VALVE.—Much difficulty is experienced from improperly constructed valves. Many valves being so constructed that large surfaces slide upon and against each other. The contact of these surfaces is expected to be steam tight, and yet freely move against each other. This is a mechanical impossibility; if such valve is anything like steam-tight, it will require a great force to move it; and should it gum or expand the least; it will stick so tight as to require a sledge to move it. If it is made to move freely, steam will pass between the surfaces, and in a short time cut a passage around the valve, instead of passing through it. Such valves should never be put on engines. The valve attached to this governor is so constructed that its opening and closing does not depend upon surfaces moving upon or against each other, but upon surfaces moving towards and from each other. The impact of the passing stream is not upon and over the surfaces that are depended upon for closing the valve, consequently the cutting of the valve by the steam will never cause it to leak. The valve has two steam passages perfectly balancing each other. The steam can never make for itself false passages, as there are no joint or openings but the proper passages for the steam.



GRADUATING VALVES.—An idea has been entertained that a valve should have an increased opening, tapering toward a point. Such valve will, as is intended, supply steam to the engine in a ratio differing from that of the action of the governor. To graduate the quantity of steam to the engine is especially the office of the governor, and any attempt to effect it in the valve acknowledges the deficiency of the governor. If the valve openings are proportioned to the supply pipe, a good governor will do all the graduating. The effect of a taper valve is but to lengthen the throw of the valve. This becomes necessary from the defects of the radial centrifugal governor, as it never acts at the proper time and always with a plunge beyond the proper point. For this reason the valve openings are made close, requiring a long throw, so that the defective governor will not at one moment cut all the steam off, and the next throw it all on. Hence a graduating valve.

THE GOVERNOR AS A CUT-OFF.—A good governor combined with a properly constructed valve constitutes perhaps the best variable cut-off made. The capacity of the valve should equal that of the pipe; the openings should be perfectly straight across, without the least taper. Such a valve will require but very little throw, and a governor acting positively and simultaneously with any change of speed in the engine will either cut off all the steam, when required, or give the boiler pressure of the steam from a change of speed impossible to be detected by the eye. With the usual variable cut-off the steam may be cut off near the beginning of the stroke, and no steam can be admitted until the beginning of the next stroke. If a heavy load be thrown on the engine immediately after the steam is cut off near the beginning of the stroke, the speed of the engine will be dragged down before steam can be admitted after passing the center.



SHIVE'S STEAM ENGINE GOVERNOR.

The manufacturers say: "By this arrangement we have the use of the steam at boiler pressure, when required, as also expansively. The steam is also admitted or cut off at any point where and when required.

"In offering this governor to the public we start out with the broad assertion that all ball governors heretofore have been constructed upon false principles—that it is false theory to swing a pendulum across the line of the power which imparts to it motion, and that a ball and arm made to vibrate in planes nearly horizontal are in a very bad position to act the part of a pendulum.

"We show by experiment that a governor so constructed that the pendulum swinging in harmony with the laws of mechanics, has a power over the best usual ball governor of like weight as ten to one, and action ten times greater. The wear and friction in the new, being perhaps one-tenth of that of the old. In mounting the old and the new upon the same shaft the defects of the old become so glaring by contrast as to excite surprise at the length of time they have been permitted to exist."

Patented May 1st, 1866. Manufactured by the Shive Governor Company, Northwest corner of Twelfth and Buttonwood Streets, Philadelphia. Pa.

Road Making by Steam.

The common practice of road making in this country, says the *Railway Times*, is one of waste and utter want of economy in every respect. The process is something like this: The upper soil is removed, and coarse gravel or broken stone supplied to bring up the grade, and the road is then left to be worn down smooth by passing teams and carriages. Think what a waste of power is thus involved, what an immense and useless wear of vehicles, what loss of time and what amount of general discomfort. Drainage is seldom thought of, and during the wet seasons, and especially when the frost is coming out of the ground, the roads are nearly impassable. The common remedy for all this is to pile on more gravel or broken stone, and then again commences the destruction of wheels. This useless tax to the owners of horses and vehicles could nearly all be prevented if the roads were properly made, drained and cared for. Proper drainage is the first essential; then the road dressed with gravel or stone should be formed and rolled into proper form to shed water—a very slight incline to either side is all that is necessary—and then you have a road that is easy to horses, and the load is carried with half the power that is expended in hauling over very many of the roads in our suburban towns. Less gravel or broken stone, but more care that it is kept in place and mooth, is what is required. In England and France they are using powerful steam rollers with beneficial results.

A London paper describes the process thus: "The road is first prepared by being loosened with pick-axes, then covered with the ordinary broken granite; above this a dressing of sand is laid; the whole is then watered. An immense roller is propelled by steam, and moved slowly over the prepared surface. It exerts a pressure of twenty-eight tuns, and the result is that in an unusually short time a firm and compact Macadamized road is formed so smoothly that the lightest vehicles may be immediately driven over it without fear of injuring the springs. The engine works almost without noise, and appears to consume nearly all its own smoke."

Daily care is required for a while, to prevent the forming of ruts; as soon as the ruts appear, they should be filled and then rolled over again. This costs something, but the event ual or resultant cost is less, both to the town authorities and those who use the roads, than is that of our present system. A smooth and even surface is nearly as important on common roads as it is on the railway. The science of road making is simple enough, but our people almost always fail in it. Once properly constructed and drained, our common roads could be kept in good working order for a tithe of what it now costs. The use of the steam roller simplifies the matter very much, and probably before long it will be freely used in nearly all our larger towns. One of these powerful steam rollers has lately been constructed in England, to be used in the United States Arsenal grounds in Philadelphia, and on trial it is found to work admirably.

ON A "PIECE OF CHALK."—A LECTURE TO WORKING-MEN.

[Concluded from page 290.]

In working over the soundings collected by Captain Dayman, I was surprised to find that many of what I have called the "granules" of that mud were not, as one might have been tempted to think at first, the mere powder and waste of *Globigerinæ*, but that they had a definite form and size. I termed these bodies *coccoliths* and doubted their organic nature. Dr. Wallich verified my observation, and added the interesting discovery, that not unfrequently bodies similar to these "coccoliths" were aggregated together into spheroids, which he termed *coccospheres* So far as we knew, these bodies, the nature of which is extremely puzzling and problematical, were peculiar to the Atlantic soundings.

But, a few years ago, Mr. Sorby, in making a careful examination of the chalk by means of thin sections and otherwise, observed, as Ehrenberg had done before him, that much of its granular basis possesses a definite form. Comparing these formed particles with those in the Atlantic soundings, he found the two to be identical; and thus proved that the chalk, like the soundings, contains these mysterious coccoliths and coccospheres. Here was a further and a most interesting confirmation, from internal evidence, of the essential identity of the chalk with modern deep-sea mud. *Globigerinæ*, coccoliths, and coccospheres are found as the chief constituents of both, and testify to the general similarity of the conditions under which both have been formed.

The evidence furnished by the hewing, facing, and superposition of the stones of the Pyramids that these structures were built by men has no greater weight than the evidence that the chalk was built by *Globigerinæ*; and the belief that those ancient pyramid builders were terrestrial and air-breathing creatures like ourselves, is not better based than the conviction that the chalk makers lived in the sea.

But as our belief in the building of the Pyramids by men is not only grounded on the internal evidence afforded by these structures, but gathers strength from multitudinous collateral proofs, and is clinched by the total absence of any reason for a contrary belief; so the evidence drawn from the *Globigerinæ*, that the chalk is an ancient sea bottom, is fortified by innumerable independent lines of evidence; and our belief in the truth of the conclusion to which all positive testimony tends receives the like negative justification from the fact that no other hypothesis has a shadow of foundation.

It may be worth while briefly to consider a few of these collateral proofs that the chalk was deposited at the bottom of the sea.

The great mass of the chalk is composed, as we have seen, of the skeletons of *Globigerinæ*, and other simple organisms, embedded in granular matter. Here and there, however, this hardened mud of the ancient sea reveals the remains of higher animals which have lived and died, and left their hard parts in the mud, just as the oysters die and leave their shells behind them in the mud of the present seas.

There are certain groups of animals at the present day which are never found in fresh waters, being unable to live anywhere but in the sea. Such are the corals: those corallines which are called *Polyzoa;* those creatures which fabricate the lamp-shells, and are called *Brachiopoda;* the pearly *Nautilus*, and all animals allied to it, and all the forms of sea-urchins and star-fishes.

Not only are all these creatures confined to salt water at the present day, but so far as our records of the past go, the conditions of their existence have been the same; hence their occurrence in any deposit is as strong evidence as can be obtained that that deposit was formed in the sea. Now the remains of animals of all the kinds which have been enumerated occur in the chalk in greater or less abundance, while not one of those forms of shell fish which are characteristic of fresh water has yet been observed in it.

When we consider that the remains of more than three thousand distinct species of aquatic animals have been discovered among the fossils of the chalk, that the great majority of them are of such forms as are now met with only in the sea, and that there is no reason to believe that any one of them inhabited fresh water—the collateral evidence that the chalk represents an ancient sea bottom acquires as great force as the proof derived from the nature of the chalk itself. I think you will now allow that I did not overstate my case when I asserted that we have as strong grounds for believing that all the vast area of dry land, at present occupied by the chalk, was once at the bottom of the sea, as we have for any matter of history whatever; while there is no justification for any other belief.

No less certain it is that the time during which the countries we now call southeast England, France, Germany, Poland, Russia, Egypt, Arabia, Syria, were more or less completely covered by a deep sea, was of considerable duration.

We have already seen that the chalk is, in places, more than a thousand feet thick. I think you will agree with me that it must have taken some time for the skeletons of animalculæ of a hundredth of an inch in diameter to heap up such a mass as that. I have said that throughout the thickness of the chalk the remains of other animals are scattered. These remains are often in the most exquisite state of preservation. The valves of the shell fishes are commonly adherent; the long spines of some of the sea-urchins, which would be detached by the smallest jar, often remain in their places. In a word, it is certain that these animals have lived and died when the place which they now occupy was the surface of as much of the chalk as had then been deposited; and that each had been covered up by the layer of *Globigerina* mud, upon which the creatures embedded a little higher up have, in like manner, lived and died. But some of these remains prove the existence of reptiles of vast size in the chalk sea. These lived their time, and had their ancestors and descendants—which assuredly implies time, reptiles being of slow growth.

There is more curious evidence, again, that the process of covering up, or, in other words, the deposit of *Globigerina* skeletons, did not go on very fast. It is demonstrable that an animal of the cretaceous sea might die, that its skeleton might lie uncovered upon the sea bottom long enough to lose all its outward coverings and appendages by putrefaction; and that, after this had happened, another animal might attach itself to the dead and naked skeleton, might grow to maturity, and might itself die before the calcareous mud had buried the whole.

Cases of this kind are admirably described by Sir Charles Lyell. He speaks of the frequency with which geologists find in the chalk a fossilized sea-urchin, to which is attached the lower valve of a *Crania*. This is a kind of shell fish, with a shell composed of two pieces, of which, as in the oyster, one is fixed and the other free.

"The upper valve is almost invariably wanting, though occasionally found in a perfect state of preservation in the white chalk at some distance. In this case we see clearly that the sea urchin first lived from youth to age, then died and lost its spines, which were carried away. Then the young *Crania* adhered to the bad shell, grew and perished in its turn; after which the upper valve was separated from the lower, before the Echinus became enveloped in chalky mud.

A specimen in the Museum of Practical Geology in London, still further prolongs the period which must have elapsed between the death of the sea-urchin and its burial by the *Globigerina*. For the outward face of the valve of a *Crania*, which is attached to a sea-urchin (*Micraster*), is itself everrun by an incrusting coralline, which spreads thence over more or less of the surface of the sea-urchin. It follows that, after the upper valve of the *Crania* fell off, the surface of the attached velve must have remained exposed long enough to allow of the growth of the whole coralline, since corallines do not live embedded in mud.

The progress of knowledge may one day enable us to deduce from such facts as these the maximum rate at which the chalk can have accumulated, and thus to arrive at the minimum duration of the chalk period. Suppose that the valve of the *Crania*, upon which a coralline has fixed itself in the way just described, is so attached to the sea-urchin that no part of it is more than an inch above the face upon which the sea-urchin rests. Then, as the coralline could not have fixed itself if the *Crania* had been covered up with chalk mud, and could not have lived had itself been so covered, it follows that an inch of chalk mud could not have accumulated within the time between the death and decay of the soft parts of the sea-urchin and the growth of the coralline to the full size which it has attained. If the decay of the soft parts of the sea-urchin, the attachment, growth to maturity, and decay of the *Crania* and the subsequent attachment and growth of the coralline took a year (which is a low estimate enough), the accumulation of the inch of chalk must have taken more than a year; and the deposit of a thousand feet of chalk must consequently have taken more than twelve thousand years.

The foundation of all this calculation, is, of course, a knowledge of the length of time the *Crania* and the coralline needed to attain their full size; and on this head precise knowledge is at present wanting But there are circumstances which tend to show that nothing like an inch of chalk has accumulated during a life of a *Crania*; and, on any probable estimate of the length of that life, the chalk period must have had a much longer duration than that thus roughly assigned to it.

Thus, not only is it certain that the chalk is the mud of an ancient sea bottom, but it is no less certain that the chalk sea existed during an extremely long period, though we may not be prepared to give a precise estimate of the length of that period in years. The relative duration is clear, though the absolute duration may not be definable. The attempt to affix any precise date to the period at which the chalk sea began or ended its existence is baffled by difficulties of the same kind. But the relative age of the cretaceous epoch may be determined with as great ease and certainty as the long duration of that epoch.

You will have heard of the interesting discoveries recently made, in various parts of Western Europe, of flint implements, obviously worked into shape by human hands, under circumstances which show conclusively that man is a very ancient denizens of these regions.

It has been proved that the old populations of Europe, whose existence has been revealed to us in this way, consisted of savages, such as the Esquimaux are now: that, in the country which is now France, they hunted the reindeer, and were familiar with the ways of the mammoth and the bison. The physical geography of France was in those days different from what it is now—the river Somme, for instance, having cut its bed a hundred feet deeper between that time and this; and it is probable that the climate was more like that of Canada or Siberia than that of Western Europe.

The existence of these people is forgotton even in the traditions of the oldest historical nations. The name and fame of them had utterly vanished until a few years back; and the amount of physical change which has been effected since their day renders it more than probable that, venerable as are some of the historical nations, the workers of the chipped flints of Hoxne or of Amiens are to them as they are to us in point of antiquity.

But, if we assign to these hoar relics of long vanished generations of men the greatest age that can possibly be claimed for them, they are not older than the drift of boulder clay, which, in comparison with the chalk, is a very juvenile deposit. You need go no further than your own seaboard for evidence of this fact. At one of the most charming spots on the coast of Norfolk, Cromer, you will see the boulder clay forming a vast mass, which lies upon the chalk, and must consequently have come into existence after it. Huge boulders of chalk are, in fact, included in the clay, and have evidently been brought to the position they now occupy by the same agency as that which has planted blocks of syenite from Norway side by side with them.

The chalk, then, is certainly, older than the boulder clay. If you ask how much, I will again take you no further than the same spot upon your own coasts for evidence. I have spoken of the boulder clay and drift as resting upon the chalk. That is not strictly true. Interposed between the chalk and the drift is a comparatively insignificant layer containing vegetable matter. But that layer tells a wonderful history. It is full of stumps of trees standing as they grew. Fir trees are there with their cones, and hazel bushes with their nuts; there stand the stools of oak and yew trees, beeches and alders. Hence this stratum is appropriately called the "forest bed."

It is obvious that the chalk must have been upheaved and converted into dry land before the timber trees could grow upon it. As the bolls of some of these trees are from two to three feet in diameter, it is no less clear that the dry land thus formed remained in the same condition for long ages And not only do the remains of stately oaks and well-grown firs testify to the duration of this condition of things, but additional evidence to the same effect is afforded by the abundant remains of elephants, rhinoceroses, hippopotamuses, and other great wild beasts, which it has yielded to the zealous search of such men as the Rev. Mr. Gunn.

When you look at such a collection as he has formed, and bethink you that these elephantine bones did veritably carry their owners about, and these great grinders crunch in the dark woods of which the forest bed is now the only trace, it is impossible not to feel that they are as good evidence of the lapse of time as the annual rings of the tree stumps.

Thus there is a writing upon the wall of cliffs at Cromer, and whoso runs may read it. It tells us, with an authority which cannot be impeached, that the ancient sea bed of the chalk sea was raised up and remained dry land until it was covered with forest, stocked with the great game whose spoils have rejoiced your geologists. How long it remained in that condition cannot be said; "but the whirligig of time brought its revenges" in those days as in these That dry land, with the bones and teeth of generations of long-lived elephants, hidden away among the gnarled roots and dry leaves of its ancient trees, sank gradually to the bottom of the icy sea, which covered it with huge masses of drift and boulder clay. Sea beasts, such as the walrus, now restricted to the extreme north, paddled about where birds had twittered among the topmost twigs of the fir trees. How long this state of things endured we know not, but at length it came to an end. The upheaved glacial mud hardened into the soil of modern Norfolk. Forests grew once more, the wolf and the beaver replaced the reindeer and the elephant; and at length what we call the history of England dawned.

Thus you have, within the limits of your own county, proof that the chalk can justly claim a very much greater antiquity than even the oldest physical traces of mankind. But we may go further, and demonstrate, by evidence of the same authority as that which testifies to the existence of the father of men, that the chalk is vastly older than Adam himself.

The Book of Genesis informs us that Adam, immediately upon his creation, and before the appearance of Eve, was placed in the Garden of Eden The problem of the geographical position of Eden has greatly vexed the spirits of the learned in such matters, but there is one point respecting which, so far as I know, no commentator has ever raised a doubt. This is, that of the four rivers which are said to run out of it, Euphrates and Hiddekel are identical with the rivers now know by the names of Euphrates and Tigris.

But the whole country in which these mighty rivers take their origin, and through which they run, is composed of rocks which are either of the same age as the chalk, or of later date, so that the chalk must not only have been formed, but after its formation the time required for the deposit of these later rocks, and for their upheaval into dry land, must have elapsed, before the smallest brook which feeds the swift stream of "the great river, the river of Babylon," began to flow.

Thus evidence which cannot be rebutted, and which need not be strengthened, though if time permitted I might indefinitely increase its quantity, compels you to believe that the earth, from the time of the chalk to the present day, has been the theater of a series of changes as vast in their amount as they were slow in their progress. The area on which we stand has been first sea and then land for at least four alternations, and has remained in each of these conditions for a period of great length

Nor have these wonderful metamorphoses of sea into land, and of land into sea, been confined to one corner of England. During the chalk period, or "cretaceous epoch," not one of the present great physical features of the globe was in existence. Our great mountain ranges, Pyrenees, Alps, Himalayas, Andes, have all been upheaved since the chalk was deposited, and the cretaceous sea flowed over the sites of Sinai and Ararat.

All this is certain, because rocks of cretaceous or still later