Chapter I.
State of the Argument

In crossing a heath, suppose I pitched my foot against a stone, and were asked how the stone came to be there, I might possibly answer, that, for any thing I knew to the contrary, it had lain there for ever: nor would it perhaps be very easy to shew the absurdity of this answer. But suppose I had found a watch upon the ground, and it should be enquired how the watch happened to be in that place, I should hardly think of the answer which I had before given, that, for any thing I knew, the watch might have always been there. Yet why should not this answer serve for the watch as well as for the stone? Why is it not as admissible in the second case, as in the first? For this reason, and for no other, viz. that, when we come to inspect the watch, we perceive (what we could not discover in the stone) that its several parts are framed and put together for a purpose, e.g. that they are so formed and adjusted as to produce motion, and that motion so regulated as to point out the hour of the day; that, if the several parts had been differently shaped from what they are, or differently sized, or placed after any other manner, or in any other order, than that in which they are placed, either no motion at all would have been carried on in the machine, or none which would have answered the use that is now served by it. To reckon up a few of the plainest of these parts, and of their offices, all tending to one result: We see a cylindrical box containing a coiled, elastic spring, which, by its endeavor to relax itself, turns round the box. We next observe a flexible chain (artificially wrought for the sake of flexure) communicating the action of the spring from the box to the fusee. We then find a series of wheels, the teeth of which catch in, and apply to, each other, conducting the motion from the fusee to the balance, and from the balance to the pointer; and at the same time, by the size and shape of those wheels, so regulating that motion, as to terminate in causing an index, by an equable and measured progression, to pass over a given space in a given time. We take notice that the wheels are made of brass, in order to keep them from rust; the springs of steel, no other metal being so elastic; that over the face of the watch there is placed a glass, a
material employed in no other part of the work, but in the room of which, if there had been any other than a transparent substance, the hour could not be seen without opening the case. This mechanism being observed (it requires indeed an examination of the instrument, and perhaps some previous knowledge of the subject, to perceive and understand it; but being once, as we have said, observed and understood), the inference, we think, is inevitable, that the watch must have had a maker: that there must have existed, at some time and at some place or other, an artificer or artificers who formed it for the purpose which we find it actually to answer; who comprehended its construction, and designed its use. /11/

I. Nor would it, I apprehend, weaken the conclusion, that we had never seen a watch made; that we had never known an artist capable of making one; that we were altogether incapable of executing such a piece of workmanship ourselves, or of understanding in what manner it was performed; all this being no more than what is true of some exquisite remains of ancient art, of some lost arts, and, to the generality of mankind, of the more curious productions of modern manufacture. Does one man in a million know how oval frames are turned? Ignorance of this kind exalts our opinion of the unseen and unknown, artist's skill, if he be unseen and unknown, but raises no doubt in our minds of the existence and agency of such an artist, at some former time, and in some place or other. Nor can I perceive that it varies at all the inference, whether the question arise concerning a human agent, or concerning an agent of a different species, or an agent possessing, in some respects, a different nature.

II. Neither, secondly, would it invalidate our conclusion, that the watch sometimes went wrong, or that it seldom went exactly right. The purpose of the machinery, the design, and the designer, might be evident, and in the case supposed would be evident, in whatever way we accounted for the irregularity of the movement, or whether we could account for it or not. It is not necessary that a machine be perfect, in order to shew with what design it was made: still less necessary, where the only question is, whether it were made with any design at all.

III. Nor, thirdly, would it bring any uncertainty into the argument, if there were a few parts of the watch, concerning which we could not discover, or had not yet discovered, in what manner they conduced to the general effect; or even some parts, concerning which we could not ascertain, whether they conduced to that effect in any manner whatsoever. For, as to the first branch of the case; if, by the loss, or disorder, or decay of the parts in
question, the movement of the watch were found in fact to be stopped, or disturbed, or retarded, no doubt would remain in our minds as to the utility or intention of these parts, although we should be unable to investigate the manner according to which, or the connection by which, the ultimate effect depended upon their action, or assistance; and the more complex is the machine, the more likely is this obscurity to arise. Then, as to the second thing supposed, namely, that there were parts which might be spared, without prejudice to the movement of the watch, and that we had proved this by experiment; these superfluous parts, even if we were completely assured that they were such, would not vacate the reasoning which we had instituted concerning other parts. The indication of contrivance remained, with respect to them, nearly as it was before.

IV. Nor, fourthly, would any man in his senses think the existence of the watch, with its various machinery, accounted for, by being told that it was one out of possible combinations of material forms; that whatever he had found in the place where he found the watch, must have contained some internal configuration or other; and that this configuration might be the structure now exhibited, viz. of the works of a watch, as well as a different structure.

V. Nor, fifthly, would it yield his enquiry more satisfaction to be answered, that there existed in things a principle of order, which had disposed the parts of the watch into their present form and situation. He never knew a watch made by the principle of order; nor can he even form to himself an idea of what is meant by a principle of order, distinct from the intelligence of the watch-maker. /13/

IV. Sixthly, he would be surprised to hear, that the mechanism of the watch was no proof of contrivance, only a motive to induce the mind to think so.

VII. And not less surprised to be informed, that the watch in his hand was nothing more than the result of the laws of metallic nature. It is a perversion of language to assign any law, as the efficient, operative cause of any thing. A law presupposes an agent; for it is only the mode, according to which an agent proceeds: it implies a power; for it is the order, according to which that power acts. Without this agent, without this power, which are both distinct from itself, the law does nothing; is nothing. The expression, "the law of metallic nature," may sound strange and harsh to a philosophic ear, but it seems quite as justifiable as some others which are more familiar to him, such as "the law of vegetable nature".-"the law of animal nature," or indeed
as "the law of nature" in general, when assigned as the cause of phenomena, in exclusion of agency and power; or when it is substituted into the place of these.

VIII. Neither, lastly, would our observer be driven out of his conclusion, or from his confidence in its truth, by being told that he knew nothing at all about the matter. He knows enough for his argument. He knows the utility of the end: he knows the subserviency and adaptation of the means to the end. These points being known, his ignorance of other points, his doubts concerning other points, affect not the certainty of his reasoning. The consciousness of knowing little, need not begat a distrust of that which he does know. /14/

CHAPTER II
STATE OF THE ARGUMENT CONTINUED

Suppose, in the next place, that the person, who found the watch, should, after some time, discover, that, in addition to all the properties which he had hitherto observed in it, it possessed the unexpected property of producing, in the course of its movement, another watch like itself; (the thing is conceivable;) that it contained within it a mechanism, a system of parts, a mould for instance, or a complex adjustment of lathes, files, and other tools, evidently and separately calculated for this purpose; let us enquire, what effect ought such a discovery to have upon his former conclusion.

I. The first effect would be to increase his admiration of the contrivance, and his conviction of the consummate skill of the contriver. Whether he regarded the object of the contrivance, the distinct apparatus, the intricate, yet in many parts intelligible, mechanism, by which it was carried on, he would perceive, in his new observation, nothing but an additional reason for doing what he had already done; for referring the construction of the watch to design, and to supreme art. If that construction without this property, or, which is the same thing, before this property had been noticed, proved intention and art to have been employed about it; still more strong would the proof appear, when he came to the knowledge of this further property, the crown and perfection of all the rest.

II. He would reflect, that though the watch before him were, in some sense, the maker of the watch, which was fabricated in the course of its movements, yet it was in a /15/ very different sense from that, in which a carpenter, for instance, is the maker of a chair; the author of its contrivance,
the cause of the relation of its parts to their use. With respect to these, the
first watch was no cause at all to the second: in no such sense as this was it
the author of the constitution and order, either of the parts which the new
watch contained, or of the parts by the aid and instrumentality of which it was
produced. We might possibly say, but with great latitude of expression, that
a stream of water ground corn: but no latitude of expression would allow us
to say, no stretch of conjecture could lead us to think, that the stream of water
built the mill, though it were too ancient for us to know who the builder was.
What the stream of water does in the affair is neither more nor less than this:
by the application of an unintelligent impulse to a mechanism previously
arranged, arranged independently of it, and arranged by intelligence, an effect
is produced, viz. the corn is ground. But the effect results from the
arrangement. The force of the stream cannot be said to be the cause or author
of the effect, still less of the arrangement. Understanding and plan in the
formation of the mill were not the less necessary, for any share which the
water has in grinding the corn: yet is this share the same, as that which the
watch would have contributed to the production of the new watch, upon the
supposition assumed in the last section. Therefore,

III. Though it be now no longer probable, that the individual watch which
our observer had found, was made immediately by the hand of an artificer,
yet doth not this alteration in any wise affect the inference, that an artificer
had been originally employed and concerned in the production. The
argument from design remains as it was. Marks of design and contrivance
are no more accounted for now, than they were before. In the same /16/
thing, we may ask for the cause of different properties. We may ask for the
cause of the colour of a body, of its hardness, of its heat; and these causes
may be all different. We are now asking for the cause of that subserviency
to an use, that relation to an end, which we have remarked in the watch before
us. No answer is given to this question by telling us that a preceding watch
produced it. There cannot be design without a designer; contrivance without
a contriver; order without choice; arrangement, without any thing capable of
arranging; subserviency and relation to a purpose, without that which could
intend a purpose; means suitable to an end, and executing their office in
accomplishing that end, without the end ever having been contemplated, or
the means accommodated to it. Arrangement, disposition of parts,
subserviency of means to an end, relation of instruments to an use, imply the
presence of intelligence and mind. No one, therefore, can rationally believe,
that the insensible, inanimate watch, from which the watch before us issued,
was the proper cause of the mechanism we so much admire in it; could be truly said to have constructed the instrument, disposed its parts, assigned their office, determined their order, action, and mutual dependency, combined their several motions into one result, and that also a result connected with the utilities of other beings. All these properties, therefore, are as much unaccounted for, as they were before.

IV. Nor is any thing gained by running the difficulty further back, i.e. by supposing the watch before us to have been produced from another watch, that from a former, and so on indefinitely. Our going back ever so far brings us no nearer to the least degree of satisfaction upon the subject. Contrivance is still unaccounted for. We still want a contriver. A designing mind is neither supplied /17/ by this supposition, nor dispensed with. If the difficulty were diminished the further we went back, by going back indefinitely we might exhaust it. And this is the only case to which this sort of reasoning applies. Where there is a tendency, or, as we increase the number of terms, a continual approach towards a limit, there, by supposing the number of terms to be what is called infinite, we may conceive the limit to be attained: but where there is no such tendency, or approach, nothing is effected by lengthening the series. There is no difference as to the point in question, (whatever there may be as to many points), between one series and another; between a series which is finite, and a series which is infinite. A chain, composed of an infinite number of links, can no more support itself, than a chain composed of a finite number of links. And of this we are assured, (though we never can have tried the experiment), because, by increasing the number of links, from ten for instance to a hundred, from a hundred to a thousand, &c. we make not the smallest approach, we observe not the smallest tendency, towards self-support. There is no difference in this respect (yet there may be a great difference in several respects), between a chain of a greater or less length, between one chain and another, between one that is finite and one that is infinite. This very much resembles the case before us. The machine, which we are inspecting, demonstrates, by its construction, contrivance and design. Contrivance must have had a contriver, design, a designer; whether the machine immediately proceeded from another machine or not. The circumstance alters not the case. That other machine may, in like manner, have proceeded from a former machine: nor does that alter the case: contrivance must have had a contriver. That former one from one preceding it: no alteration still: a contriver is still necessary. No tendency /18/ is perceived, no approach towards a diminution of this necessity. It is the same
with any and every succession of these machines; a succession of ten, of a hundred, of a thousand; with one series as with another: a series which is finite, as with a series which is infinite. In whatever other respects they may differ, in this they do not. In all equally, contrivance and design are unaccounted for.

The question is not simply, How came the first watch into existence? which question, it may be pretended, is done away by supposing the series of watches thus produced from one another to have been infinite, and consequently to have had no such first, for which it was necessary to provide a cause. This, perhaps, would have been nearly the state of the question, if nothing had been before us but an unorganized, unmechanized, substance, without mark or indication of contrivance. It might be difficult to shew that such substance could not have existed from eternity, either in succession (if it were possible, which I think it is not, for unorganized bodies to spring from one another), or by individual perpetuity. But that is not the question now. To suppose it to be so, is to suppose that it made no difference whether we had found a watch or a stone. As it is, the metaphysics of that question have no place; for, in the watch which we are examining, are seen contrivance, design; an end, a purpose, means for the end, adaptation to the purpose. And the question, which irresistibly presses upon our thoughts, is, whence this contrivance and design. The thing required is the intending mind, the adapting hand, the intelligence by which that hand was directed. This question, this demand, is not shaken off, by increasing a number or succession of substances, destitute of these properties; nor the more, by increasing that number to infinity. If it be said, that, upon the supposition of one watch being produced from another in the course of one other's movements, and by means of the mechanism within it, we have a cause for the watch in my hand, viz. the watch from which it proceeded. I deny, that for the design, the contrivance, the suitableness of means to an end, the adaptation of instruments to an use (all which we discover in the watch), we have any cause whatever. It is in vain, therefore, to assign a series of such causes, or to allege that a series may be carried back to infinity; for I do not admit that we have yet any cause at all of the phenomena, still less any series of causes either finite or infinite. Here is contrivance, but no contriver; proofs of design, but no designer.

V. Our observer would further also reflect, that the maker of the watch before him, was, in truth and reality, the maker of every watch produced from it; there being no difference (except that the latter manifests a more exquisite
skill) between the making of another watch with his own hands, by the mediation of files, lathes, chisels, &c. and the disposing, fixing, and inserting of these instruments, or of others equivalent to them, in the body of the watch already made, in such a manner, as to form a new watch in the course of the movements which he had given to the old one. It is only working by one set of tools, instead of another.

The conclusion which the first examination of the watch, of its works, construction, and movement, suggested, was, that it must have had, for the cause and author of that construction, an artificer, who understood its mechanism, and designed its use. This conclusion is invincible. A second examination presents us with a new discovery. The watch is found, in the course of its movement, to produce another watch, similar to itself: and not only so, but we perceive in it a system of organization, separately calculated for that purpose. What effect would this discovery have, or ought it to have, upon our former inference? What, as hath already been said, but to increase, beyond measure, our admiration of the skill, which had been employed in the formation of such a machine? Or shall it, instead of this, all at once turn us round to an opposite conclusion, viz. that no art or skill whatever has been concerned in the business, although all other evidences of art and skill remain as they were, and this last and supreme piece of art be now added to the rest? Can this be maintained without absurdity? Yet this is atheism.

CHAPTER III.
APPLICATION OF THE ARGUMENT

This is atheism: for every indication of contrivance, every manifestation of design, which existed in the watch, exists in the works of nature; with the difference, on the side of nature, of being greater and more, and that in a degree which exceeds all computation. I mean that the contrivances of nature surpass the contrivances of art, in the complexity, subtlety, and curiosity of the mechanism; and still more, if possible, do they go beyond them in number and variety: yet, in a multitude of cases, are not less evidently mechanical, not less evidently contrivances, not less evidently accommodated to their end, or suited to their office, than are the most perfect productions of human ingenuity.

I know no better method of introducing so large a subject than that of comparing a single thing with a single thing: an eye, for example, with a
telescope. As far as the examination of the instrument goes, there is precisely the same proof that the eye was made for vision as there is that the telescope was made for assisting it. They are made upon the same principles, both being adjusted to the laws by which the transmission and refraction of rays of light are regulated. I speak not of the origin of the laws themselves; but such laws being fixed, the construction in both cases is adapted to them. For instance, these laws require, in order to produce the same effect, that rays of light in passing from water into the eye should be refracted by a more convex surface than when it passes out of air into the eye. Accordingly, we find that the eye of a fish, in that part of it called the crystalline lens, is much rounder than the eye of terrestrial animals. What plainer manifestation of design can there be than this difference? What could a mathematical instrument maker have done more to show his knowledge of his principle, his application of that knowledge, his suiting of his means to his end; I will not say to display the compass or excellence of his skill and art, for in these all comparison is indecorous, but to testify counsel, choice, consideration, purpose?

To some it may appear a difference sufficient to destroy all similitude between the eye and the telescope, that the one is a perceiving organ, the other an unperceiving instrument. The fact is that they are both instruments. And as to the mechanism, at least as to the mechanism being employed, and even as to the kind of it, this circumstance varies not the analogy at all. For observe what the constitution of the eye is. It is necessary, in order to produce distinct vision, that an image or picture of the object be formed at the bottom of the eye. Whence this necessity arises, or how the picture is connected with the sensation, or contributes to it, it may be difficult, nay, we will confess, if you please, impossible for us to search out. —But the present question is not concerned in the inquiry. It may be true, that, in this and in other instances, we trace mechanical contrivance a certain way, and that then we come to something which is not mechanical, or which is inscrutable. But this affects not the certainty of our investigation, as far as we have gone. The difference between an animal and an automatic statue consists in this, that in the animal we trace the mechanism to a certain point, and then we are stopped, either the mechanism being too subtle for our discernment, or something else beside the known laws of mechanism taking place; whereas, in the automaton, for the comparatively few motions of which it is capable, we trace the mechanism throughout. But, up to the limit, the reasoning is as clear and certain in the one case as in the other. In the example before us it is a matter of certainty, because it is a matter which experience and
observation demonstrate, that the formation of an image at the bottom of the eye is necessary to perfect vision. The formation then of such an image being necessary - no matter how - to the sense of sight and to the exercise of that sense, the apparatus by which it is formed is constructed and put together not only with infinitely more art, but upon the selfsame principles of art as in the telescope or the camera obscura [OED: an instrument consisting of a darkened chamber or box, into which light is admitted by a double convex lens, forming an image of external objects, on a surface of paper, glass, etc., placed at the focus of the lens]. The perception arising from the image may be laid out of the question; for the production of the image, these are instruments of the same kind. The end is the same, the means are the same. The purpose in both is alike, the contrivance for accomplishing that purpose is in both alike. The lenses of the telescopes and humours of the eye bear a complete resemblance to one another, in their figure, their position, and in their power over the rays of light, namely, in bringing each pencil to a point at the right distance from the lens; namely, in the eye, at the exact place where the /23/ membrane is spread to receive it. How is it possible, under circumstances of such close affinity, and under the operation of equal evidence, to exclude contrivance from the one, yet to acknowledge the proof of contrivance having been employed, as the plainest and clearest of all propositions, in the other?

The resemblance between the two cases is still more accurate, and obtains in more points than we have yet represented, or than we are, on the first view of the subject, aware of. In dioptric [OED: assisting vision by means of refractive lenses] telescopes there is an imperfection of this nature. Pencils of light in passing through glass lenses are separated into different colors, thereby tingeing the object, especially the edges of it, as if it were viewed through a prism. To correct this inconvenience had been long a desideratum [object of desire] in the art. At last it came into the mind of a sagacious optician to inquire how this matter was managed in the eye, in which there was exactly the same difficulty to contend with as in the telescope. His observation taught him that in the eye the evil was cured by combining lenses composed of different substances, that is, of substances which possessed different refracting powers. Our artist borrowed thence his hint and produced a correction of the defect by imitating, in glasses made from different materials, the effects of the different humours through which the rays of light pass before they reach the bottom of the eye. Could this be in the eye without purpose, which suggested to the optician the only effectual means of attaining
that purpose?

But further, there are other points not so much perhaps of strict resemblance between the two as of superiority of the eye over the telescope, yet of a superiority which, being founded in the laws that regulate both, may furnish topics of fair and just comparison. Two things were wanted to the eye, which were not wanted, at least in the same degree, to the telescope; and these were the adaptation of the organ, first, to different degrees of light, and secondly, to the vast diversity of distance at which objects are viewed by the naked eye, namely, from a few inches to as many miles. These difficulties present not themselves to the maker of the telescope. He wants all the light he can get; and he never directs his instrument to objects near at hand. In the eye, both these cases were to be provided for; and for the purpose of providing for them, a subtle and appropriate mechanism is introduced.

I. In order to exclude excess of light when it is excessive, and to render objects visible under obscurer degrees of it when no more can be had, the hole or aperture in the eye, through which the light enters, is so formed as to contract or dilate itself for the purpose of admitting a greater or less number of rays at the same time. The chamber of the eye is a camera obscura which, when the light is too small, can enlarge its opening; when too strong, can again contract it; and that without any other assistance than that of its own exquisite machinery. It is further also in the human subject to be observed that this hole in the eye, which we call the pupil, under all its different dimensions retains its exact circular shape. This is a structure extremely artificial. Let an artist only try to execute the same. He will find that his threads and strings must be disposed with great consideration and contrivance to make a circle which shall continually change its diameter, yet preserve its form. This is done in the eye by an application of fibers, i.e., of strings, similar in the position and action to what an artist would and must employ if he had the same piece of workmanship to perform.

II. The second difficulty which has been stated was the suiting of the same organ to the perception of objects that lie near at hand, within a few inches, we will suppose, of the eye, and of objects which were placed at a considerable distance from it, that, for example, of as many furlongs (I speak in both cases of the distance at which distinct vision can be exercised). Now this, according to the principles of optics, that is, according to the laws by which transmission of light is regulated (and these laws are fixed), could not be done without the organ itself undergoing an alteration and receiving an adjustment that might correspond with the exigency of the case, that is to
say, with the different inclination to one another under which the rays of light reached it. Rays issuing from points placed at a small distance from the eye, and which consequently must enter the eye in a spreading or diverging order cannot, by the same optical instrument in the same state, be brought to a point, i.e., be made to form an image, in the same place with rays proceeding from objects situated at a much greater distance, and which rays arrive at the eye in directions nearly, and physically speaking, parallel. It requires a rounder lens to do it. The point of concourse behind the lens must fall critically upon the retina, or the vision is confused; yet this point, by the immutable properties of light, is carried further back when the rays proceed from a near object than when they are sent from one that is remote. A person who was using an optical instrument would manage this matter by changing, as the occasion required, his lens or his telescope; or by adjusting the distance of his glasses with his hand or his screw: but how is it to be managed in the eye? What the alteration was, or in what part of the eye it took place, or by what means it was effected (for, if the known laws which govern the refraction of light be maintained, some alteration in the state of the organ there must be), had long formed a subject of enquiry and conjecture. /26/ The change, though sufficient for the purpose, is so minute as to elude ordinary observation. Some very late discoveries, deduced from a laborious and most accurate inspection of the structure and operation of the organ, seem at length to have ascertained the mechanical alteration which parts of the eye undergo. It is found that by the action of certain muscles called the straight muscles -- and which action is the most advantageous that could be imagined for the purpose -- it is found, I say, that whenever the eye is directed to a near object, three changes are produced in it at the same time, all severally contributing to the adjustment required. The cornea, or outermost coat of the eye, is rendered more round and prominent; the crystalline lens underneath is pushed forward; and the axis of vision, as the depth of the eye is called, is elongated. These changes in the eye vary its power over the rays of light in such a manner and degree as to produce exactly the effect which is wanted, viz., the formation of an image upon the retina, whether the rays come to the eye in a state of divergency, which is the case when the object is near to the eye, or come parallel to one another, which is the case when the object is placed at a distance. Can any thing be more decisive of contrivance than this is? The most secret laws of optics must have been known to the author of a structure endowed with such a capacity of change. It is as though an optician, when he had a nearer object to view, should rectify his instrument by putting in
another glass, at the same time drawing out also his tube to a different length.../28/

But this, though much, is not the whole: by different species of animals the faculty we are describing is possessed, in degrees suited to the different range of vision which their mode of life and of procuring their food requires. Birds, for instance, in general procure their food by means of their beak; and the distance between the eye and the point of the beak being small, it becomes necessary that they should have the power of seeing very near objects distinctly. On the other hand, from being often elevated much above the ground, living in air, and moving through it with great velocity, they require for their safety, as well as for assisting them in descrying their prey, a power of seeing at great distance; a power of which, in birds of rapine, surprising examples are given. The fact accordingly is that two peculiarities are found in the eyes of birds, both tending to facilitate the change upon which the adjustment of the eye to different distances depends. The one is a bony, yet in most species, a flexible rim or hoop, surrounding the broadest part of the eye which, confining the action of the muscle to that part, increases the effect of their lateral pressure upon the orb, by which pressure its axis is elongated for the purpose of looking at very near objects. The other is an additional muscle called the marsupium, to draw, upon occasion, the crystalline lens back, and to fit the same eye for the viewing of very distant objects. By these means the eyes of birds can pass from one extreme to another of their scale of adjustment, with more ease and readiness than the eyes of other animals.

The eyes of fishes also, compared with those of terrestrial animals, exhibit certain distinctions of structure, adapted to their state and element. We have already observed /29/ upon the figure of the crystalline compensating by its roundness the density of the medium through which their light passes. To which we have to add, that the eyes of fish, in their natural and indolent [OED: idle] state, appear to be adjusted to near objects, in this respect differing from the human eye, as well as those of quadrupeds and birds. The ordinary shape of the fish's eye being in a much higher degree convex than that of land animals, a corresponding difference attends its muscular conformation, viz., that it is throughout calculated for flattening the eye.

The iris also in the eyes of fish does not admit of contraction. This is a great difference, of which the probable reason is that the diminished light in water is never too strong for the retina.
In the eel, which has to work its head through sand and gravel, the roughest and harshest substances, there is placed before the eye, and at some distance from it, a transparent, horny, convex case or covering which, without obstructing the sight, defends the organ. To such an animal, could any thing be more wanted, or more useful?

Thus, in comparing together the eyes of different kinds of animals, we see in their resemblances and distinctions one general plan laid down, and that plan varied with the varying exigencies to which it is to be applied.

There is one property, however, common, I believe, to all eyes, at least to all which have been examined, namely, that the optic nerve enters the bottom of the eye, not in the center or middle, but a little on one side; not in the point where the axis of the eye meets the retina, but between that point and the nose. –The difference which this makes is, that no part of an object is unperceived by both eyes at the same time. /30/

In considering vision as achieved by the means of an image formed at the bottom of the eye, we can never reflect without wonder upon the finalness, yet correctness, of the picture, the subtlety of the touch, the fineness of the lines. A landscape of five or six square leagues is brought into a space of half an inch diameter; yet the multitude of objects which it contains are all perceived, are all discriminated in their magnitudes, positions, figures, colors. The prospect from Hampstead Hill is compressed into the compass of a sixpence, yet circumstantially represented. A stage coach traveling at its ordinary speed for half an hour passes, in the eye, only over one-twelfth of an inch, yet is this change of place in the image distinctly perceived throughout its whole progress; for it is only by means of that perception that the motion of the coach itself is made sensible to the eye. If anything can abate our admiration of the smallness of the visual tablet compared with the extent of vision, it is a reflection, which the view of nature leads us every hour to make, viz., that in the hands of the Creator, great and little are nothing.

Sturmius held that the examination of the eye was a cure for atheism. Besides that conformity to optical principles – which its internal constitution displays, and which alone amounts to a manifestation of intelligence having been exerted in its structure – besides this, which forms no doubt the leading character of the organ, there is to be seen in everything belonging to it and about it an extraordinary degree of care, an anxiety for its preservation due, if we may so speak, to its value and its tenderness. It is lodged in a strong, deep, bony pocket composed by the junction of seven different bones hollowed out at their edges. In some few species, as that of the coatimondi,
the orbit is not bony throughout; but whenever this is the case, the upper, which is the deficient part, is supplied by a cartilaginous ligament: a substitution which shews the same care. Within this socket it is imbedded in fat, of all animal substances the best adapted both to its repose and motion. It is sheltered by the eyebrows, an arch of hair which, like a thatched penthouse, prevents the sweat and moisture of the forehead from running down into it.

But it is still better protected by its lid. Of the superficial parts of the animal frame, I know none which, in its office and structure, is more deserving of attention than the eyelid. It defends the eye; it wipes it; it closes it in sleep. Are there, in any work of art whatever, purposes more evident than those which this organ fulfills, or an apparatus for executing those purposes more intelligible, more appropriate, or more mechanical? If it be overlooked by the observer of nature, it can only be because it is obvious and familiar. This is a tendency to be guarded against. We pass by the plainest instances whilst we are exploring those which are rare and curious, by which conduct of the understanding we sometimes neglect the strongest observations, being taken up with others which, though more recondite and scientific, are as solid arguments entitled to much less consideration.

In order to keep the eye moist and clean, which qualities are necessary to its brightness and its use, a wash is constantly supplied by a secretion for the purpose, and the superfluous brine is conveyed to the nose through a perforation in the bone as large as a goose quill. When once the fluid has entered the nose, it spreads itself upon the inside of the nostril, and is evaporated by the current of warm air which, in the course of respiration, is continually passing over it. Can any pipe or outlet for carrying off the waste liquor from a dye-house or a distillery be more mechanical than this is? It is easily perceived that the eye must want moisture; but could the want [needs] of the eye generate the gland which produces the tear, or bore the hole by which it is discharged -- a hole through a bone?

It is observable that this provision is not found in fish, the element in which they live supplying a constant lotion to the eye.

It were, however, injustice to dismiss the eye as a piece of mechanism, without noticing that most exquisite of all contrivances, the nictitating membrane, which is found in the eyes of birds and of many quadrupeds. Its use is to sweep the eye, which it does in an instant; to spread over it the lacrymal humour; to defend it also from sudden injuries; yet not totally, when drawn upon the pupil, to shut out light. The commodiousness with which it
lies folded up in the upper corner of the eye, ready for use and action, and the
quickness with which it executes its purpose, are properties known and
obvious to every observer: but what is equally admirable, though not quite so
obvious, is the combination of two different kinds of substance, muscular and
elastic, and of two different kinds of action, by which the motion of this
membrane is performed. It is not, as in ordinary cases, by the action of two
antagonist muscles, one pulling forward and the other backward, that a
reciprocal change is effected; but it is thus: The membrane itself is an elastic
substance, capable of being drawn out by force like a piece of elastic gum,
and by its own elasticity returning, when the forces is removed, to its former
position. Such being its nature, in order to fit it up for its office, it is
connected by a tendon or thread with a muscle in the back part of the
eye: this tendon or thread, though strong, is so fine as not to obstruct the
sight, even when it passes across it; and the muscle itself, being placed in the
back part of the eye, derives from its situation the advantage not only of being
secure, but of being out of the way; which it would hardly have been in any
position that could be assigned to it in the anterior part of the orb, where its
function lies. When the muscle behind the eye contracts, the membrane, by
means of the communication thread, is instantly drawn over the fore part of
it. When the muscular contraction (which is a positive, and, most probably,
voluntary effort, ) ceases to be exerted, the elasticity alone of the membrane
brings it back again to its position. Does not this, if any thing can do it,
bespeak an artist, master of his work, acquainted with his materials? “Of a
thousand other things,” say the French Academicians, “we perceive not the
contrivance, because we understand them only by the effects, of which we
know not the causes; but we here treat of a machine, all the parts whereof are
visible; and which need only be looked upon to discover the reasons of its
motion and action.”

In the configuration of the muscle, which, though placed behind the eye,
draws the nictitating membrane over the eye, there is what the authors, just
now quoted, deservedly call a marvelous mechanism. I suppose this structure
to be found in other animals; but, in the Memoirs from which this account is
taken, it is anatomically demonstrated only in the cassowary. The muscle is
passed through a loop formed by another muscle; and is there inflected, as
if it were round a pulley. This is a peculiarity; and observe the advantage
of it. A single muscle with a straight tendon, which is the common muscular
form, would have been sufficient, if it had had power to draw far enough. But
the contraction, necessary to draw the membrane over the whole eye, required
a longer muscle than could lie straight at the bottom of the eye. Therefore, in order to have a greater length in a less compass, the cord of the main muscle makes an angle. This, so far, answers the end; but, still further, it makes an angle, not round a fixed pivot, but round a loop formed by another muscle; which second muscle, whenever it contracts, of course twitches the first muscle at the point of inflection, and thereby assists the action designed by both.

One question may possibly have dwelt in the reader's mind during the perusal of these observations, namely, why should not the Deity have given to the animal the faculty of vision at once? Why this circuitous perception; the ministry of so many means; an element [light] provided for the purpose; reflected from opaque substances, refracted through transparent ones, and both according to precise laws; then a complex organ, an intricate and artificial apparatus, in order, by the operation of this element, and in conformity with the restrictions of these laws, to produce an image upon a membrane communicating with the brain? Wherefore all this? Why make the difficulty in order to surmount it? If to perceive objects by some other mode than that of touch, or objects which lay out of the reach of that sense, were the thing proposed, could not a simple volition of the Creator have communicated the capacity? Why resort to contrivance where power is omnipotent? Contrivance, by its very definition and nature, is the refuge of imperfection. /35/ To have recourse to expedients implies difficulty, impediment, restraint, defect of power. This question belongs to the other senses as well as to sight, to the general functions of animal life, as nutrition, secretion, respiration; to the economy of vegetables - and indeed to almost all the operations of nature. The question, therefore, is of very wide extent; and among other answers which may be given to it, beside reasons of which probably we are ignorant, one answer is this: it is only by the display of contrivance that the existence, the agency, the wisdom of the Deity could be testified to his rational creatures. This is the scale by which we ascend to all the knowledge of our Creator which we possess, so far as it depends upon the phenomena or the works of nature. Take away this, and you take away from us every subject of observation and ground of reasoning; I mean, as our rational faculties are formed at present. Whatever is done, God could have done without the intervention of instruments or means; but it is in the construction of instruments, in the choice and adaptation of means, that a creative intelligence is seen. It is this which constitutes the order and beauty of the universe. God, therefore, has been pleased to prescribe limits to his
own power and to work his ends within those limits. The general laws of
matter have perhaps prescribed the nature of these limits; its inertia; its
reaction; the laws which govern the communication of motion, the refraction
and reflection of light, and the constitution of fluids nonelastic and elastic,
the transmission of sound through the latter; the laws of magnetism, of
electricity, and probably others yet undiscovered. These are general laws; and
when a particular purpose is to be effected, it is not by making a new law, nor
by the suspension of the old ones, nor by making them wind and bend, and
yield to the occasion - for nature with great steadiness adheres to and supports
them - but it is, as we have seen in the eye, by the interposition of an
apparatus corresponding with these laws, and suited to the exigency which
results from them, that the purpose is at length attained. As we have said,
therefore, God prescribes limits to his power that he may let in the exercise,
and thereby exhibit demonstrations, of his wisdom. For then - that is, such
laws and limitations being laid down - it is as though one Being should have
fixed certain rules, and, if we may so speak, provided certain materials, and
afterwards have committed to another Being, out of these materials and in
subordination to these rules, the task of drawing forth a creation: a
supposition which evidently leaves room, and induces indeed a necessity for,
contrivance. Nay, there may be many such agents, and many ranks of these.
We do not advance this as a doctrine either of philosophy or of religion; but
we say that the subject may safely be represented under this view, because the
Deity, acting himself by general laws, will have the same consequences upon
our reasoning as if he had prescribed these laws to another. It has been said
that the problem of creation was "attraction and matter being given, to make
a world out of them"; and, as above explained, this statement perhaps does
not convey a false idea.

We have made choice of the eye as an instance upon which to rest the
argument of this chapter. Some single example was to be proposed; and the
eye offered itself under the advantage of admitting of a strict comparison with
optical instruments. The ear, it is probable, is no less artificially and
mechanically adapted to its office, than the eye; but we know less about it: we
do not so well understand the action, the use, or the mutual dependency of its
internal parts...