IV. *Account of a Petrefaction found on the Coaſt of* Eaſt Lothian. *By* Edward King, *Eſq. F. R. S.*

TO SIR JOHN PRINGLE, BART. P. R. S.

SIR,

John-ſtreet, November 14, 1778.

Read Nov. 26, 1778.

IN conſequence of the honour you did me, to put into my hands a very curious ſpecimen of a recent petrefaction, permit me now to offer to your conſideration a few thoughts concerning this production, which have occurred to me on comparing it with others of a ſimilar kind, and which may at leaſt ſerve as hints for further inveſtigation.

We ſhould not venture, it is true, without great caution, to ſpeculate on theſe matters, as haſty and ſpecious concluſions may eaſily be drawn by any one who indulges too readily a quick and lively imagination, which will ever be too ready to miſlead, rather than to procure ſolid information. But though I

am well aware of this danger, yet I venture to lay before you theſe few obſervations; and if you judge them at all worthy of attention, I would wiſh to communicate them, through your hands, to the Royal Society, for they are not made merely in conſequence of a ſlight and haſty ſurvey of this one ſpecimen, but are in truth concluſions that I have been led to form incidentally in the courſe of a very long inquiry, which I have been for ſome years purſuing on another occaſion; the reſult whereof I ſhall perhaps, if I live, hereafter communicate to the Society in a more full and explicit manner than the compaſs of a paper of this kind will permit.

The account of this ſpecimen, with which you favoured me, is as follows. In the year 1745, the Fox man of war was unfortunately ſtranded on the coaſt of Eaſt Lothian in Scotland, and there went to pieces; and the wreck remained about three and thirty years under water; but this laſt year a violent ſtorm from the North-eaſt laid a part of it bare, and ſeveral maſſes, conſiſting of iron, ropes, and balls, were found on the ſands near the place, covered over with a very hard ochry ſubſtance, of the colour of iron, which adhered thereto ſo ſtrongly, that it required great force to detach it from the fragments of the wreck. And, upon examination, this ſub-

ſtance

ſtance appeared to be ſand, concreted and hardened into a kind of ſtone.

The ſpecimen now laid before the Society had been taken out of the ſea, from the ſame ſpot, ſome time before, and is a conſolidated maſs that had undergone the ſame change. It contains a piece of rope that was adjoining to ſome iron ring, and probably had been tied thereto. The ſubſtance of the rope is very little altered; but the ſand is ſo concreted round it, as to be as hard as a bit of rock, and retains very perfectly impreſſions of parts of the ring, juſt in the ſame manner as impreſſions of extraneous foſſil bodies are often found in various kinds of ſtrata.

Now, conſidering theſe circumſtances, we may fairly conclude, in the firſt place, that there is, on the coaſts of this iſland, a continual progreſſive induration of maſſes of ſand and other matter at the bottom of the ocean, ſomewhat in the ſame manner as there is at the bottom of the Adriatic ſea, according to the account given by Dr. DONATI[(a)].

And, in the next place (which is what more particularly deſerves our attention on this occaſion), it ſhould ſeem, that iron, and the ſolutions of iron, contribute very much to haſten and promote the progreſs of the concretion and induration of ſtone, whenever they meet and are

(a) See the Phil. Tranſ. vol. XLIX. p. 588.

united

united with thoſe cementing cryſtalline particles, which there is reaſon to believe are the more immediate cauſe of the conſolidation of all ſtones and marbles whatſoever, and which do very much abound in ſea water.

It would exceed the limits of this paper, were I to attempt here to mention only a ſmall part of the various facts that have come to my knowledge; and which have convinced me, and I truſt, when offered fairly to the conſideration of others, will make it appear fully to all that are attentive to theſe kind of reſearches, that there is, to this very day, a formation of ſtone, and even of marble itſelf, in certain places, in a much more perfect manner, than has been generally conceived; and far beyond what has been ſuppoſed, even by thoſe who have been ready too haſtily to account for ſuch a proceſs merely in conſequence of obſervations made on ſtalactitical and ſuch like ordinary concretions.

I ſhall not therefore preſume to trouble the Society, at preſent, with any detail of the inquiries I have made relating to that ſubject, though in reality they have been the foundation of the obſervations made in this paper; but ſhall confine my remarks merely to this one curious circumſtance; that wherever there is any induration and petrefaction of matter, from any cauſes whatever, it is greatly haſtened in its progreſs, and the conſolidation is rendered much more compleat and firm by being

being near any maſs of iron, and ſtill more ſo by the admixture of any ſolution of that metal.

This appears, in ſome degree, from the preſent ſpecimen; where, near adjoining to the ring, and in the portion of the fragment that has the largeſt impreſſion thereof, the concreted ſand-ſtone is of a firmer texture, and there is a larger cohering maſs formed about that part of the rope, than about thoſe parts that are further removed from the ring.

It appears alſo from a circumſtance that was particularly taken notice of when the wreck was diſcovered by the ſtorm this year (and which is mentioned, SIR, in the letter you favoured me with a ſight of); for the maſſes that were obſerved to have theſe concretions adhering to them, were not maſſes of timber, or other large fragments of the wreck, which one would think, on a ſlight conſideration of the matter, were moſt likely to cauſe obſtructions at the bottom of the ocean, and to form little banks of ſand, that might afterwards be concreted; but they were maſſes of looſe iron and ropes, and even of cannon balls, which were thus conſolidated.

The ſame concluſion alſo may be drawn, with ſtill more appearance of its being well founded, from a very remarkable piece of antiquity, which was diſcovered about three years ago on the coaſt of Kent. Some fiſhermen, ſweeping for anchors in the Gull ſtream (a part of

the ſea near the Downs), drew up a very curious old ſwivel gun, near eight feet in length. The barrel of the gun, which was about five feet long, was of braſs; but the handle (whereby it was to be turned or traverſed) which was about three feet in length, and alſo the ſwivel and pivot on which it turned, were of iron, and all round theſe latter, and eſpecially about the ſwivel and pivot, were formed exceeding hard incruſtations of ſand, converted into a kind of ſtone, of an exceeding ſtrong texture and firmneſs; whereas round the barrel of the gun, except where it was near adjoining to the iron, there were no ſuch incruſtations at all, the greater part of it being clean, and in good condition, juſt as if it had ſtill continued in uſe[b].

The incruſtation round the iron part of this gun was alſo the more deſerving of attention, becauſe it incloſed within it, and alſo held faſtly adhering to it on the outſide, a number of ſhells and corallines, juſt in the ſame manner as they are often found in a foſſil ſtate. There were plainly to be diſtinguiſhed, on the outſide of this maſs of incruſtation, pectens, cockles, limpets, muſcles, *vermiculi marini* and *balini*; and beſides theſe, one *bucci-*

(*b*) As there were ſeveral remarkable particularities in this gun, tending to explain ſome curious facts in hiſtory, I took the liberty to give a full account of it, with a view to illuſtrate them, in a memoir laid before the Antiquarian Society laſt year.

num

num[c] and one oyſter; and they were all ſo thoroughly and ſtrongly fixed thereto, and themſelves alſo converted into ſuch an hard ſubſtance, that it required as much force to ſeparate or break them, as to break a fragment off any hard rock; and in colour and appearance, they much reſembled ſome of the maſſes of foſſil bodies found near Chippenham in Wiltſhire.

This remarkable incruſtation, therefore, thus confined to the parts of the gun adjoining to the iron, and appearing no where elſe upon it, plainly indicates, that the iron was, by ſome means or other, the more immediate cauſe thereof: and yet it is to be obſerved, that in this inſtance the iron was very little diſſolved; for although it is manifeſt, from ſome circumſtances in its hiſtory, that the gun muſt have remained in the ſea above two hundred years, and probably a great deal longer, yet the greater part of the handle and of the ſwivel remained entire, and even the point of the pivot was undiſſolved, and very viſible.

Another curious appearance alſo, of a ſimilar nature, will tend further to confirm the obſervations here made. This is found in a ſpecimen (now in my poſſeſſion) of a moſt remarkable incruſtation, that was formed in the ſpace of three years only, within a ſquare wooden pipe, in a Coal Mine in Somerſetſhire. I gave a very particu-

(c) See the figure marked G 41.

lar account of this production in a paper laid before the Society in the year 1773[d], and therefore ſhall ſay nothing of it here but what immediately relates to the preſent purpoſe. The pipe was forty-two feet in length, and the hollow part of it was ſeven inches and an half wide, by four inches and an half; and this whole cavity was ſo filled with the incruſted matter (which was hard enough to take an exceeding fine poliſh, like the moſt beautiful marble) that at laſt there was left a water way, which, nearly uniformly throughout the whole length of the pipe, was only about three inches and an half by one inch; and thus there was formed, within the firſt wooden pipe, a ſecond pipe of this incruſtration, the thickneſs of the ſides of which was about one inch and an half. On cutting a tranſverſe ſection of this pipe there appeared a number of uniform lines, forming almoſt regular ſimilar parallelograms, one within another, like the coats of an onion, and plainly denoting the gradual and regular progreſs of the formation of the whole incruſtation. But the circumſtance moſt remarkable, and that is more immediately applicable to the preſent purpoſe, is, that where there was, by accident, the point of a nail projecting through the ſide of the wooden pipe, it ſo accelerated the progreſs of the incruſtation, that, adjoining thereto, the ſimilar ſides of the firſt and outward

(d) Phil. Tranſ. vol. LXIII. p. 241.

parallelograms next the wooden pipe (inſtead of continuing as ſtraight lines) formed in that place very bold ſemi-circular curves, or protuberances, one beyond another, projecting from the wooden pipe inwards; and this curvilinear projection was uniformly continued throughout all the ſimilar parallelograms quite to the inward cavity of the pipe formed by the incruſtation, and there at laſt occaſioned a projecting gibboſity, of a conſiderable extent every way, from the point of the nail[e].

Having mentioned theſe remarkable facts to my very learned and ingenious friend Dr. FOTHERGILL, I had the pleaſure to find they ſtruck him much in the ſame light in which they had appeared to me; and that he, moreover, formed the ſame concluſion concerning the ſpecimen now laid before the Society that you had alſo formed and mentioned in the note you favoured me with when you ſent the ſpecimen to my houſe; namely, that the concretion was effected by the ſolution of the adjoining iron ring.

Dr. FOTHERGILL alſo (who had communicated ſome very original conjectures upon this ſubject to the Society many years[f] ago) informed me of ſome further

(e) There is another fragment of the incruſtation formed within this pipe, with a tranſverſe ſection thereof poliſhed, in the Muſeum of the Royal Society; but that with the point of the nail, which is here alluded to, is ſtill in my poſſeſſion.

(f) In a paper on the Origin of Amber, read in the year 1743.

curious facts, which he permits me now to mention in this paper.

On paſſing through the ſtreets of London in his walks, before the ſign-irons were taken down, he perceived, that on the broad ſtone pavements, whenever he came juſt under any ſign-irons, his cane gave a different ſound, and occaſioned a different kind of reſiſtance to the hand, from what it did elſewhere; and attending more particularly to this circumſtance, he found, that every where, under the drip of thoſe irons, the ſtones had acquired a greater degree of ſolidity, and a wonderful hardneſs, ſo as to reſiſt any ordinary tool, and gave, when ſtruck upon, a metallic ſound: and this fact, by repeated obſervations, he was at length moſt thoroughly convinced of.

Taking the hint, therefore, from hence, he thought fit to make ſeveral experiments; and, amongſt the reſt, placed two pieces of Portland ſtone in the ſame aſpect and ſituation in every reſpect, but waſhed the one frequently with water impregnated with ruſty iron, and left the other untouched: and in a very few years he found the former had acquired a very ſenſible degree of that hardneſs before deſcribed, and on being ſtruck gave the metallic ſound; whilſt the other remained in its original ſtate, and ſubject to the decays occaſioned by the changes

of

of the weather, which we find in many inſtances make a moſt rapid progreſs.

He alſo mentioned to me a very curious circumſtance of his having found on the ſea-coaſt near Scarborough, many years ago, part of an horſe-ſhoe incruſted with ſea ſand, which was ſo concreted as to have acquired the hardneſs of common grit ſtone, and retained the colour of the ſand, with very little tincture of the iron ochre: and by the part which was left free from the incruſtation it appeared moſt probable, that the horſe-ſhoe had not been buried there many years, but had very recently acquired this incruſtation upon that part only that was moſt expoſed to the waſhing of the ſea water.

Now, all theſe facts put together ſcarce leave any doubt but that iron, and ſolutions of iron, do grealy promote and haſten the progreſs of all kinds of petrifaction; and therefore, to purſue Lord BACON's rule of induction, deducing truth from a variety of facts and experiments, all manifeſtly and uniformly leading us to the ſame concluſion, we may fairly infer, that whereas iron is of ſuch manifeſt uſe in the progreſs of vegetation, that plants are indebted for their green colour[g], and for

(g) There are ſome exceeding curious experiments and obſervations of Mr. DELAVAL's, tending to illuſtrate this fact, in the Phil. Tranſ. vol. LV. p. 36, 37.

many of their valuable qualities, to its being intimately mixed in their ſubſtance; and as it is moreover obviouſly uſeful, ſome way or other, in the animal ſyſtem, and may be extracted by the magnet from the aſhes of animal ſubſtances; ſo it is no leſs uſeful in the conſolidation of ſtones and marble in the foſſil world.

Mr. PRYCE, in a very uſeful and curious treatiſe of Mineralogy (*b*), has moreover lately ſhewn it to be equally uſeful in the mineral world, by forming a proper *nidus* for the aſſemblage of the moſt valuable metals, and attracting and uniting them thereby. This metal, therefore, ſeems to be almoſt univerſally one of the greateſt bands that unites the ſeveral parts of matter, and one of the moſt uſeful and important of ſubſtances in the world.

It is not for us to preſume to comprehend any thing about the original formation of bodies. Such diſquiſitions are far out of the reach of our faculties; nor do I at all pretend to enter into them: but we are permitted to behold and conſider the works of the Almighty, and may become wiſer and reap profit from the contemplation of them, and may perceive in what manner many new combinations of matter are continually effected.

And as we manifeſtly perceive plants to grow daily for the neceſſary ſupplies of life, without knowing how

(*b*) Mineralogia Cornubienſis, p. 6. 11. 67.

they

they grow; but yet are convinced they are nouriſhed by means of the ſalts and particles of matter conveyed to them by water and vapour, and that iron is a neceſſary ingredient in their compoſition; ſo I am perſuaded we ſhall, at length, perceive (notwithſtanding the general opinion to the contrary) that even ſtones and marbles are ſtill continually forming in the earth for the ſervices of human life, and to ſupply the continual waſte and decay that there is of thoſe ſubſtances; and that the conſolidation of them is effected by means of water and vapour likewiſe (of which I am able to produce very many and convincing proofs); and that iron, which is what alone I wiſh now to make apparent, is unqueſtionably a principal means of effecting the induration of many of thoſe bodies.

But I would not willingly trouble the Society with this paper as a matter of mere ſpeculation. I would wiſh that ſome hint, which might be more immediately uſeful, ſhould, if poſſible, be derived therefrom; and ſuch has been ſuggeſted to me by Dr. FOTHERGILL.

If iron and the ſolutions of iron do thus contribute to the induration of bodies, ſuch ſolutions muſt probably have that tendency in every ſtage of thoſe bodies' exiſtence; and therefore it ſeems likely, that the fine ornamental carvings in Portland, or other ſtone, might be much

much hardened, and preſerved for a much longer time than has been uſual, from the injuries of the weather, by being waſhed and bruſhed over by water, in which is infuſed a ſolution of iron. And perhaps even the ſofter kinds of ſtones might have been preſerved by this means; and the venerable remains of that fine pile of building HENRY the VIIth's chapel, might have been ſaved from the deſtruction with which we now ſee it ready to be overwhelmed.

It is very probable, moreover, that common ſea ſand, with a very ſmall admixture of a ſolution of iron, may at length, without any great expence, be converted into a moſt uſeful ſpecies of ſtone, and be applied to the purpoſe of covering the fronts of houſes even more durably, and in as beautiful a manner as ſome of the late invented ſtuccos; and even thoſe ſtuccos may be improved by means of the ſame mixture.

It muſt be left to future experiments to aſcertain what proportions of the ſolutions of iron are beſt to be made uſe of; and in what manner the ſolution may beſt be obtained for this purpoſe; whether by a vitriolic acid; or merely by laying ruſty iron for ſome time in water (i). But one caution ſhould be obſerved; namely, that if too

(i) It is not perhaps poſſible to contrive a leſs ſaturated tincture of iron than the ruſt diſſolved in water.

great

great a proportion of vitriolic acid be left in the mixture, it may do more miſchief than the iron can do good. With this caution it were perhaps much to be wiſhed, that experiments[(h)] ſhould be made, and attended to, for a long courſe of years; for without ſuch continued and repeated trials, it will be impoſſible to determine in what manner the application may be made with moſt advantage.

I have only therefore to add, that what has been ſaid may perhaps receive ſome further confirmation, from conſidering that the chief conſtituent parts of all cements for ſtone are always lime and iron[(i)]; and that any experiments made in conſequence of theſe obſervations will be likely to ſucceed more rapidly in warm climates than in colder ones.

Whatever there is of inaccuracy in this ſhort paper will I am perſuaded meet with indulgence both from you and from the Society, whilſt whatever truth is brought to light thereby will be received and adopted. I therefore venture to deliver it into your hands without heſitation. I am, &c.

(h) The ages of modern buildings are eaſily known, and there are none but what have iron rails or bars about them expoſed to the weather. If the rain drops from them on Portland or any gritty ſtone, it becomes harder. The length of time ſuch ſtones have been ſubjected to this proceſs may eaſily be known, and the effects produced in them may be verified by repeated compariſons of different fragments.

(i) See CROUSTEDST's Mineralogy, p. 45.

I have added a few rough ſketches to explain what has been ſaid in this letter.

FIG I. Repreſents the maſs of concreted ſand and rope from the coaſt of Lothian.

AB ſhews where there is one impreſſion of a part of the iron ring.

CD ſhews were there is alſo another impreſſion of the ring; and

EF ſhews where there alſo remain ſome impreſſions of bits of untwiſted rope, ſo that this whole maſs ſeems to have been formed within the circumference of the ring.

FIG. II. Repreſents a tranſverſe ſection of the petrefaction within the wooden pipe, from the coal mine in Somerſetſhire; and

G ſhews the place of the point of the nail, and the regular curvilinear projection of the petrefaction around it, regularly throughout the whole progreſs.

FIG. III. Is a ſketch of the gun, ſhewing the parts to which the incruſtation adhered.

Fig: I.

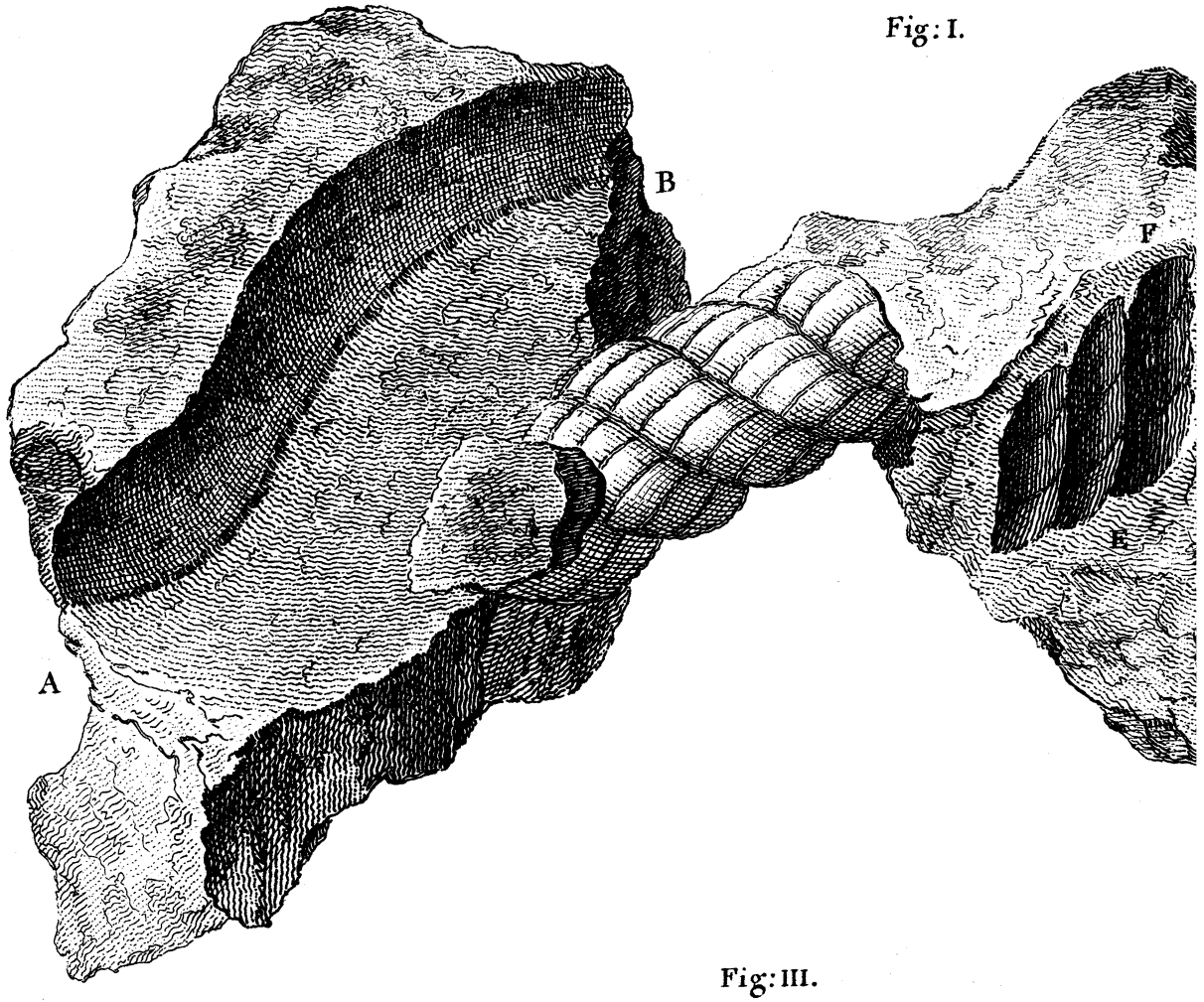
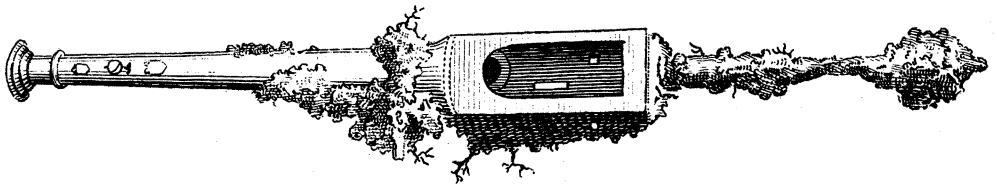


Fig: III.



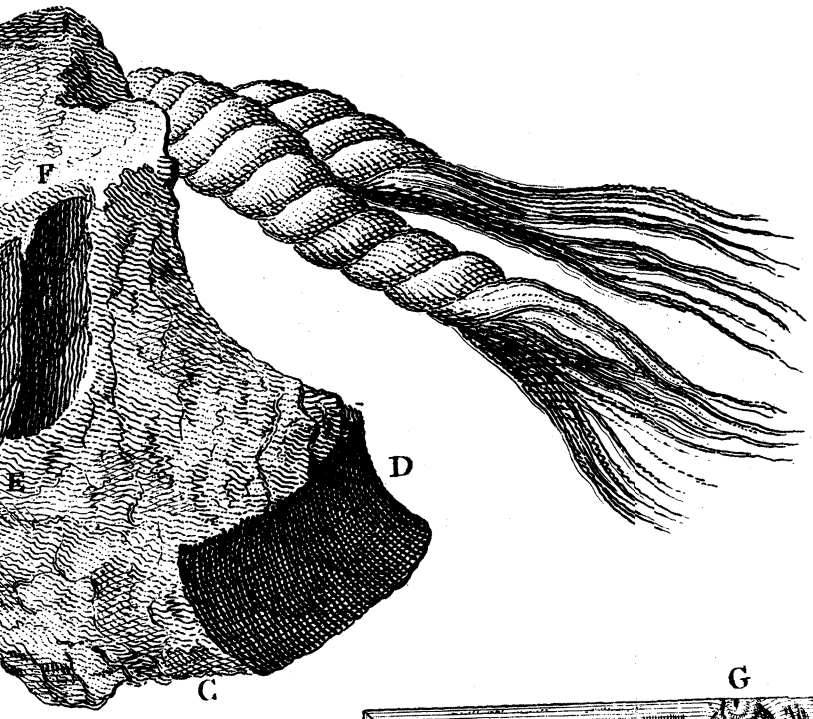
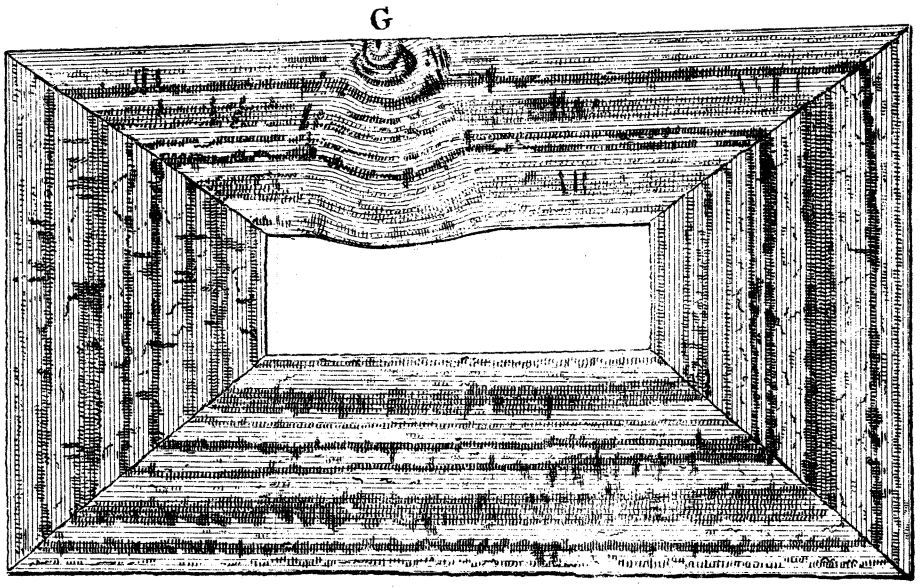


Fig: II.



b. I. p. 50.

Fig: I.

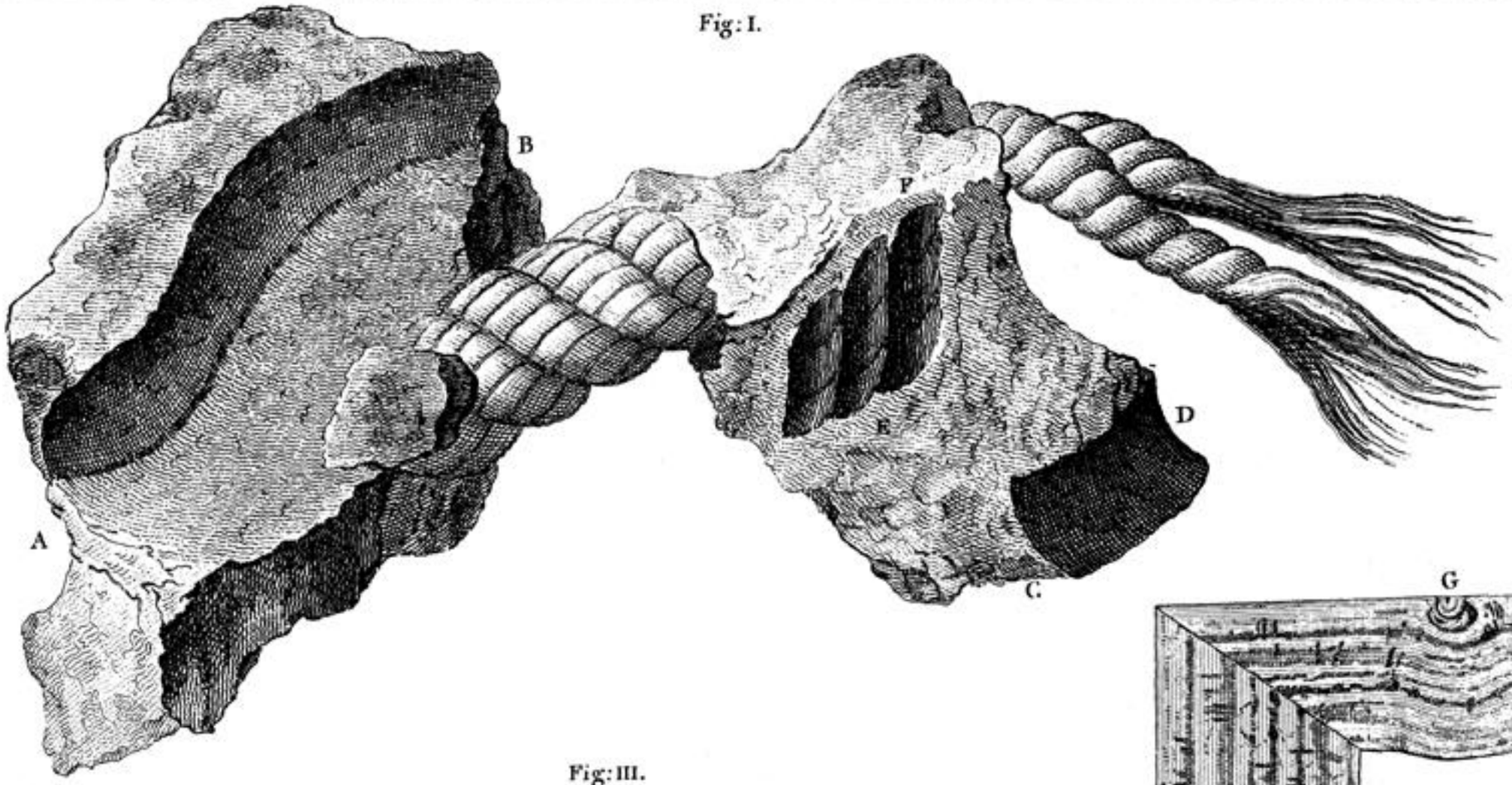


Fig: II.

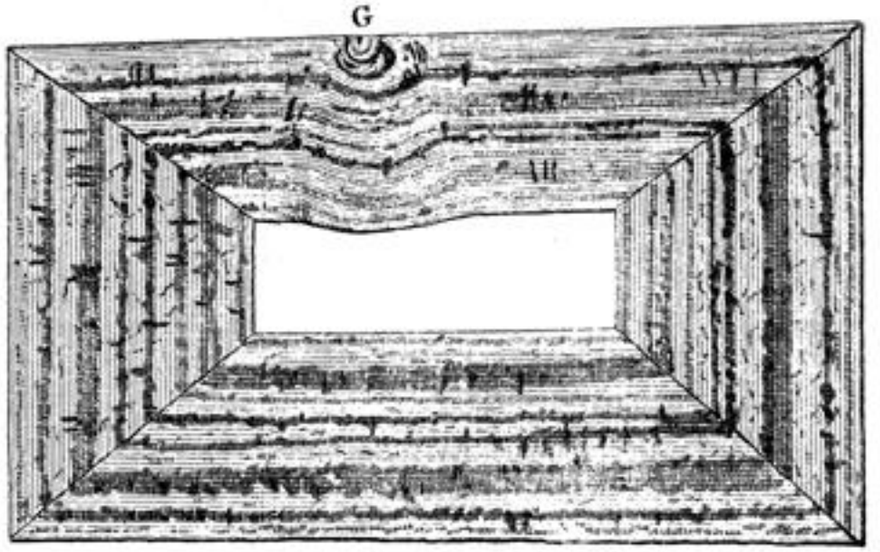


Fig: III.