

The art of drawing in perspective made easy. To those who have no previous knowledge of the mathematics / By James Ferguson ... Illustrated with plates.

Contributors

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THE
ART
OF
DRAWING IN PERSPECTIVE
MADE EASY

To those who have no previous Knowledge of
the MATHEMATICS.

By JAMES FERGUSON, F.R.S.

Illustrated with PLATES.



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P R E F A C E.

IN my infirm state of health, a situation that is very apt to affect the mental faculties, I thought my late book of Mechanical Exercises would have been the last I should ever publish. But, as I have been constantly accustomed to an active life, and to consider idleness as an insupportable burden, I have, of late, amused myself at intervals, as my usual business would permit, with studying *Perspective*; which is an art that every one who makes drawings, were it but for plates (especially of solid figures) in books, should be acquainted with. And indeed I drew the figures which

are now engraved for this Book, with no other view than to instruct others verbally by, who came to me to learn something of that branch of science, without having the least thought of ever laying them before the Public.

But, upon shewing these drawings accidentally to some friends, they expressed their desire that I should write a description of the rules by which they were delineated. I complied with their desire, and it is entirely owing to their partiality to me, that I have consented to this publication.

I need not observe how requisite it is for painters who put groupes of figures together, but also for those who draw landscapes, or figures of machines and engines for books, to

know the rules of Perspective. The want of this branch of knowledge is the reason why we not only see very bad and distorted figures of machines and engines in printed books, but also why we see many historical paintings, in which the different pictures of men, women, hills, houses, birds, and beasts, are put together without any regard to what painters call *keeping*; which is the same thing as *representing* objects in the same manner that they appear to the eye, at different distances from it.

I shall only mention two instances in the works of one of the greatest painters that ever existed;—I mean the celebrated RAPHAEL URBIN.

Every man is sensible, that, if he should stand by the sea-side, and look

at a boat with men in it at some distance, he could not distinctly see the features of those men, much less the wrinkles and marks of the muscles in their faces or bare arms. And if he were in a boat, at some distance from the land, he could not perceive the eyes and beaks of fowls on the shore.

Yet so it is, that, in one of the famous *Cartons* of RAPHAEL, representing the miraculous draught of fishes, the men in each of the two boats appear of full size, the features of their faces strongly marked; and the boats are represented so small, and the men so big, that any one of them appears sufficient to sink either of the boats by his own bare weight: and the fowls on the shore are likewise drawn so big,

big, as to seem very near the eye of the observer; who could not possibly, in that case, distinguish the features of the men in the distant boats. Or, supposing the observer to be in either of the boats, he could not see the eyes or beaks of the fowls on the shore.

The other instance is of a very capital mistake in Raphael's historical picture of our SAVIOUR'S transfiguration on the Mount; where he is represented with those who were then with him, almost as large as the rest of his disciples at the foot of the Mount, with the father and mother of the boy whom they brought to be cured: and the mother, though on her knees, is more than half as tall as the Mount is high. So that the Mount appears only of the size of a little

little hay-rick, with a few people on its top, and a greater number at its bottom on the ground: in which case, a spectator at a little distance could as well distinguish the features of those on the top as of those on the ground. But upon any large eminence, deserving the name of a Mount, *that* would be quite impossible.—My only reason for mentioning these extraordinary particulars, is to shew, how necessary it is for painters to be well acquainted with the rules of Perspective.

I am far from considering the following Work as a complete system of *Perspective*, for *that* would require a very large volume. But I think I may venture to say, that, when the learner is fully master of what is there contained, he will not find any great difficulty

difficulty in proceeding to what length he pleases in the attainment of this science, without any further assistance.—Or, if he should grow tired, and be weary of going on according to the rules, he may make use of the Perspective Machine described and delineated at the end of this small tract, by which he may draw every thing equally easy that he sees before him, without knowing any rule at all. But I hope there are very few who will have recourse to such an unscientific method.

It is very probable, that those who already understand Perspective, if they take the trouble of reading this small Treatise, may think I have been rather too verbose in most of my descriptions. I only request of such to consider,

sider, that I never wrote any thing for those who are well skilled in the few branches of science whereof I have treated ; but only for those who wish to attain a moderate knowledge of them ; and to such, I think, every thing ought to be made as plain and easy, and be as minutely described, as is possible.

Perspective

Perspective made Easy.

CHAP. I.

The THEORY of PERSPECTIVE.

I. **P**ERSPECTIVE is the art of drawing the resemblances or pictures of objects on a plane surface, as the objects themselves appear to the eye.—Thus, suppose a person at a window looks through an upright pane of glass at any object beyond it; and, keeping his head steady, draws the figure of the object
B upon

upon the glass, with a black lead pencil, as if the point of the pencil touched the object itself; he would then have a true representation of the object in perspective, as it appears to his eye.

In order to this, two things are necessary: first, that the glass be laid over with strong gum-water, which, when dry, will be fit for drawing upon, and will retain the traces of the pencil: and, secondly, that he looks through a small hole in a thin plate of metal, fixed about a foot from the glass, between it and his eye, and that he keeps his eye close to the hole; otherwise he might shift the position of his head, and consequently make a false delineation of the object.

Having

Having traced out the figure of the object, he may go over it again with pen and ink; and, when that is dry, put a sheet of paper upon it, and trace it thereon with a pencil: then, taking away the paper, and laying it on a table, he may finish the picture, by giving it the colours, lights, and shades, as he sees them in the object itself; and then he will have a true resemblance of the object.

2. The nearer that any object is to the eye, the bigger it appears: the farther from the eye, so much the less, both in height and breadth.

3. All objects become visible by the rays of light which flow from them into the eye. These rays pass through the pupil, and fall upon the retina,

which is a fine expansion of the optic nerve, interwoven like net-work in the back-part or bottom of the eye; and there the rays form a picture of the object, whose apparent bulk depends upon the size of such picture, so formed upon the retina.

In Fig. 1. of Plate I. let $PbdcaP$ be the eye, P the pupil, or round black opening in the middle or fore-part of the eye, through which the rays of light enter, and proceed to the retina or back-part $bcd a$, where they are intercepted, and form the pictures of the objects from which they flow. Every point of the object throws off rays of light in all manner of straight-lined directions; and therefore, every visible point of an object will send some rays through the pupil into the
eye;

eye; and these rays, falling upon the retina, will form all the corresponding points of the picture or image of the object thereon. The rays are coloured according to the colours of the objects they flow from, and give the like colours to its picture formed in the eye.

4. To shew that the pictures of objects are thus formed upon the retina, take the eye of a sheep or bullock, newly killed, and cut off all the opaque part from the outside of the back of the eye, till the transparent retina appears; then hold up the eye between your own eye and any object, with the fore-part of the eye toward the object, and you will see a fine inverted picture of the object on the retina, having all the colours of the object itself.

5. In Fig. 1. let AeB be an object, whose distance from the eye is Pe . A ray APa from the top of the object, passing through the pupil P of the eye, and going on to the retina, forms the picture or image of the point A thereon, at a ; and a ray BPb , from the foot of the object, passing through the pupil P , and going on to the retina, forms the image of the point B at b on the retina.—All the intermediate points of the object, from A to B , send rays of light into the eye, which form all the intermediate points of the image between a and b in the eye. So that the image of the object is inverted in the eye; and its whole length is included between the points a and b on the retina. Those who want to know why we see the objects themselves in an inverse position

tion to that of their pictures in the eye, must read what optical writers have said on that subject.

Let the same object be placed twice as far from the eye, as at CD ; then the distance Pf will be double the distance Pe . The ray CPc forms the image of the top C at c on the retina, and the ray DPd forms the image of the bottom-point D of the object at d on the retina.—Now it is plain, that as the space between c and d is only equal to half the space between a and b , the image of the object will be but half as long upon the retina, when the distance Pf of the object is twice as great as its distance Pe was before.—And thus, by removing the object further and further from the eye, or removing the eye further and further

from the object, it would seem at last to be no bigger than a mere point, because the angle under which it was then seen would be next to nothing.

6. An ANGLE is formed by two lines approaching toward each other till they meet; and the point where they meet is termed *the angular point*. Thus, in Fig. 1. the lines AP and BP tending toward one another, form an angle; and the point where they meet at P is the angular point: and whether these lines be long or short, it makes no alteration in what is termed *the measure of the angle*; as we shall shew in the next section.

In describing an angle, three letters are generally used, the middle letter always meaning the angular point
where

where the two lines meet.—Thus, APB denotes the angle formed by the two lines AP and BP , meeting at P ; and CPD denotes the angle formed by the two lines CP and DP , meeting at P .—In this case, as the object AeB subtends (or is seen under) the angle APB , and the object CfD is seen under the angle CPD , the former is called the angle of vision of the object AeB , and the latter the angle of vision of the object CfD . But, as the lines CP and DP fall within the lines AP and BP , the angle of vision of CfD is less than the angle of vision of AeB ; and just as much less as the distance of the object CfD , from the eye, is greater than the distance of the object AeB from it.—So that the apparent height (or breadth) of any object is directly as the measure of the angle under which it is seen.

7. If

7. If a circle, of any diameter whatever, be divided into 360 equal parts or degrees, and the angular point be at the center, the number of degrees between the two lines which form the angle is the measure thereof. Thus, in Fig. 2. of Plate I. the lines AC and BC form the angle ACB ; of which, the point C at the center of the semicircle $dABe$ is the angular point; and the number of degrees of the semicircle contained between the points A and B , in the arc AB , is the measure of the angle ACB .

Let the semicircle be divided into three equal parts, as dA , AB , and Be ; then each part will contain 60 degrees (the whole semicircle containing 180) and *that* will be the measure of either of the three angles dCA , ACB , or BCe .

Join the points A and B by the straight line AB , and a triangle will be formed by the three lines CA , AB , and BC , all of equal length; and all the three angles at A , B , and C , will be equal, each containing 60 degrees. —So likewise, in the lesser semicircle $kabl$, the lines ab , bC , and Ca are of equal length; and each angle, at C , a , and b , contains 60 degrees.

8. Any triangle whose sides are all equal, is called *an equilateral triangle*; and the angle opposite to either side thereof contains 60 degrees.

9. *To make an equilateral triangle upon a line of any given length*, as suppose the line AB (Plate I. Fig. 2.): take the length AB between the points of your compasses, and, with that extent,

tent, set one foot on the end of the line at *A*, and with the other foot describe the arc *fCg*; then, without altering the compasses, set one foot on the end *B*, and with the other foot describe the arc *bCi*: lastly, from the ends *A* and *B* draw the two lines *AC* and *BC* to the intersection of these arcs at *C*; and you will have an equilateral triangle, formed by the three lines or sides *AB*, *BC*, and *CA*; and each side will subtend an angle of 60 degrees.—In the same manner may an equilateral triangle be made upon the given line *ab*, by the lines *bC* and *Ca*.

10. No object can be wholly and distinctly seen (if the eye be kept steady while looking at it) under a larger angle than that of 60 degrees,
—Thus,

—Thus, an eye at C may see the whole line or object AB (or ab) without moving or straining, when the distance of the eye from each end of the line is just equal to the length of the line, or object.—And as this is generally reckoned to be a good angle of vision, we shall keep generally by it, in the following practical part of this Work, where the representations of large objects are delineated. But it will not do so well in representing small objects, which are better seen under a smaller angle than that of 60 degrees: for, when a person looks at a common drinking-glass, or a die, he never brings it so near to his eye (unless he be very near-sighted) as to view it under so large an angle as that of 60 degrees; because experience teaches him, that he can see
it

it better under a smaller angle; that is, when at a greater distance from his eye.—Thus, the small object ab will be better seen by an eye at D , viewing it under an angle of 30 degrees (as aDb), than if his eye were only at half that distance at C , viewing the same object ab under an angle (aCb) of 60. And therefore, in delineating the perspective figures of small objects, the artist should always suppose the observer to be so far off from the object, as to be viewing it under a less angle than that of 60 degrees: and then the perspective picture will appear more natural, and consequently so much the more pleasing to the eye.

11. When a person stands right against the middle of one end of a
long

long avenue or walk, which is straight, and equally broad throughout; the sides thereof seem to approach nearer and nearer to each other as they are further and further from his eye, as the angles under which their different parts are seen become less and less, according as the distance from his eye increases (§ 2. and 5.); and if the avenue be very long, the sides of it at the farthest end will seem to meet: and *there*, an object that would cover the whole breadth of the avenue, and be of a height equal to that breadth, would appear only to be a mere point.

Thus, in Fig. 3. of Plate I. let AB be part of one side of a long avenue, DC as much of the other side thereof, and these sides be parallel to each other;

other ; and suppose the avenue to be divided into equal squares, as $AefD$, $egbf$, $gikh$, &c. A person standing at O will see these two sides as if they were gradually approaching toward one another, as in Fig. 4. ; and the squares will seem to diminish in size as they are further and further from his eye. So that the first square $AefD$ in Fig. 3. will appear as $AefD$ in Fig. 4. the second square $egbf$ in Fig. 3. will appear as $egbf$ in Fig. 4. and so on, till the last square of the avenue, produced to the utmost bounds of sight, would vanish into a point, as S in Fig. 4. where the sides AS and DS meet.

12. The point S , where the parallel sides of the avenue seem to meet, is called *The Point of Sight* ; the point O ,
I
where

where the observer's eye is placed, is called *The Place of the Observer*: the line SP , passing through the point of sight, is called *The Horizon*; and a point taken therein, either to the right or left hand from S , and as far from S as O is from S , is called *The Point of Distance*.——*N. B.* In whatever point the observer's eye is supposed to be placed, either for a direct or oblique view of the side of the object that is nearest to him, a straight line drawn from the point of sight to his eye must be perpendicular to the horizon; which will be nearer to the eye, or further from it, as the observer is supposed to stand upon lower or higher ground.

C H A P. II.

The PRACTICE of PERSPECTIVE.

O P E R A T I O N I.

To put a Square in Perspective, as viewed by an Observer standing right against the Middle of one of its Sides, and having his Eye above the Plane of the Square.

13. **I**N Fig. 5. of Plate I. let $ABCD$ be a square, viewed by an observer at O , who sees the side AD (next to him) under the angle ACD of 60 degrees (§ 10.).

Make AD in Fig. 6. equal to AD in Fig. 5. At any convenient distance,
draw

draw the horizon SP parallel to AD . Take O , the place of the observer, according to the rule in § 9.; and from the point O , make OS perpendicular to SP , meeting it in S , which shall be the point of sight (§ 12.).

Take OS in your compasses, and setting one foot in S , describe the quadrant (OpP) of a circle, meeting the horizon in P , which, in all cases, shall be the true point of distance (§ 12.).

From A and D (the ends of the side of the square next the observer at O) draw the straight lines AS and DS to the point of sight S : then, from A , draw the straight line AP to the point of distance P in the horizon, cutting the line DS in the point C : this done, draw BC parallel to AD ; and $ABCD$

will be a true perspective representation of the first square $ABCD$ in Fig. 5. as seen by an observer at O .

Remark. If the observer (Fig. 6.) had stood further than O from the side AD of the square, as suppose at o , he would have seen that side under a less angle than 60 degrees; as the angle AoD is less than the angle AOD : and then, the point of distance must have been at d in the horizon; because the point of distance in the horizon must *always* be taken as far from the point of sight therein, as the place of the observer (O or o) is from the point of sight, as we shall prove in § 14.; and that, if the point of distance in the horizon be taken either nearer to or further from the point of sight than the distance of the observer
is

is supposed to be from that point, there will unavoidably be a false perspective representation of the object.

For, suppose the placing of the point of distance in the horizontal line be left to the discretion of the artist, as is generally done by writers on the science of perspective, and that he had put it at e (Fig. 6.) in the line SP ; then, a straight line drawn from A to e would have cut the line DS in the point b ; and gb (parallel to AD) would have been the top of the square $AgbD$; but it is plain to the eye and judgment, that $AgbD$ would have been a very bad and unnatural perspective representation of the square $ABCD$ in Fig. 5. Or, supposing the point of distance (Fig. 6.) to have been taken at f , in the horizon SP , the straight

line Af would have cut DS in k ; and ik would have been the top of the square. But a child could tell, that $AikD$ would be a monstrous representation of a square in perspective.

The angle of 60 degrees is only assumed here, as being the largest angle under which the eye can see an object distinctly; and not as a constant angle, under which all representations in perspective must be drawn. See § 10.

A Demonstration of the above Rule (§ 12. and 13.) for finding the true Point of Distance.

14. In Fig. 1. of Plate II. let AI and DK be part of the two parallel sides of a straight avenue, divided into equal squares,

squares, as $ABCD$, $BEFC$, $EGHF$, &c. and let trees be planted at the corners of each square, as at A , B , C , D , E , F , G , H , I , and K .

Let O be the place of the observer, SP his horizon, and S the utmost point of his view, called the point of sight; from which, the line SO is perpendicular to SP (see § 12.). To him, the two sides of the avenue seem to come nearer and nearer to one another, as they are farther and farther from his eye, tending toward the point of sight S , in the direction of the two straight lines AS and DS . § 11.

In the parallel-sided avenue, draw a straight line BO from the tree B to the observer's eye at O ; this line cuts the perspective side AS of the avenue

in the point b , which is the apparent place of the tree as seen by the observer. From the tree C draw the straight line CO to the observer's eye at O , and that line will cut the perspective side DS of the avenue in the point c , which is the apparent place of the tree as seen from O : then draw bc parallel to AD , and $AbcD$ will be the true perspective representation of the square $ABCD$.

In like manner, from the other trees, E, G, I , and F, H, K , draw straight lines to the observer's eye at O ; and these lines will cut the perspective sides AS and DS of the avenue in the points e, g, i , and f, h, k ; which are the apparent places of the trees, as seen by the observer. Lastly, draw the lines ef, gh, ik , parallel to AD ,

AD, and they will divide the perspective view of the avenue so as to make it a just representation thereof, with all its trees and squares, as seen from *O*.

Thus we find, the apparent places of the trees *B, E, G, I*, must demonstratively be at *b, e, g, i*; and that the apparent places of the trees *C, F, H, K*, must be at *c, f, h, k*, as seen from the point *O*:—the trees *A* and *D*, which are nearest to the eye, appear in their true places.—Now we shall see, by placing the point of distance in the horizon *SP* according to the above-mentioned rule, whether we shall or shall not have the apparent places of the trees in the same points as before; without drawing lines from their true places in the sides of the avenue to the observer's eye at *O*.

Take

Take SP equal to SO , and call P the point of distance. From A draw the straight line AP , intersecting the perspective side DS of the avenue in the point c , and to that point draw bc parallel to AD ; and you have the first perspective square $AbcD$ of the avenue, the very same as was found before, by the lines BO and CO .

From the point b draw bP , intersecting DS in the point f ; and to that point draw ef parallel to AD , and you have the second perspective square $befc$, the same as before.

From the point e draw eP , intersecting DS in the point h , and draw gh parallel to AD ; then, $eghf$ will be the third perspective square of the avenue, as before.

From

From the point g draw gP , intersecting DS in the point k , and draw ik parallel to AD , which finishes the fourth and last perspective square $gikb$ of the avenue.

In the same manner you may go on, drawing as many more perspective squares up toward S as you please.

Now, as the straight lines AP , bP , eP , and gP , (all drawn to the point of distance P) give the same points b , e , g , i , and c , f , h , k , for the apparent places of the trees as viewed from O , that the lines BO , EO , GO , IO , and CO , FO , HO , and KO , gave before, when drawn from the places of the trees themselves; it is plain that we have put the point of distance P
in

in the very point where it ought to be; that is, just as far from the point of sight S as the observer's eye at O is from it.

And hence it is evident, that, supposing the eye to be at O , if the point of distance had been taken any where between P and S in the horizon SP , all the lines drawn from it into the perspective avenue $AikD$ would have gone above their true places, and would have given the points for the apparent places of the trees beyond those in which the eye at O could see them; and would also have made all the perspective squares in the avenue too broad.—On the contrary, if the point of distance had been taken any where beyond P from S , all the lines drawn from *that* point of distance would

would have gone below their true places in the perspective avenue; and consequently have brought the apparent places of the trees too near the observer's eye, and have made all the perspective squares of the avenue narrower than they could really appear to the observer at *O*.

15. Hence it is manifest, that, when large objects are to be drawn in perspective, the point of distance must be taken at least as far from the point of sight, as the observer could stand from the point of sight when he sees the side of the object next to him under an angle of 60 degrees. But in drawing agreeable perspective views of small objects, the observer should be considered as viewing them under an angle not exceeding 30 degrees at most:

most: and supposing him to see them under that angle, take the distance of his place from the point of sight in your compasses, and set off that extent from the point of sight in the horizon, to find the point of distance therein.

O P E R A T I O N II.

To put a Square in Perspective, as seen by a Person not standing right against the Middle of either of its Sides, but rather nearly even with one of its Corners.

16. In Fig. 7. of Plate I. let $ABCD$ be a true square, viewed by an observer, not standing at o , directly against the middle of its side AD , but at O almost even with its corner D ,

D , and viewing the side AD under the angle AOD ; the angle AoD (under which he would have seen AD from o) being 60 degrees.

Make AD in Fig. 8. equal to AD in Fig. 7. and draw SP and OO parallel to AD . Then, in Fig. 8. let O be the place of the observer's eye, and SO be perpendicular to SP (as before, § 12, 13.) then S shall be the point of sight in the horizon SP .

Take SO in your compasses, and set that extent from S to P : then P shall be the true point of distance, taken according to the foregoing rules, § 12. and 13.

From A and D draw the straight lines AS and DS : draw also the straight line AP , intersecting DS in C .

Laſtly, to the point of interſection *C* draw *BC* parallel to *AD*; and *ABCD* in Fig. 8. will be a true perſpective representation of the ſquare *ABCD* in Fig. 7. The point *M* is the center of each ſquare, and *AMC* and *BMD* are their diagonals.

OPERATION III.

*To put a reticulated Square in Perſpective,
as ſeen by a Perſon ſtanding oppoſite to the
Middle of one of its Sides.*

17. A reticulated ſquare is one that is divided into ſeveral little ſquares, like net-work, as Fig. 4. of Plate II. each ſide of which is divided into four equal parts, and the whole ſurface into four times four (or 16) equal ſquares.

Having

Having divided this square into the given number of lesser squares, draw the two diagonals $A \times C$ and $B \times D$.

Make AD in Fig. 5. equal to AD in Fig. 4. and divide it into four equal parts, as Ae , eg , gi , and iD .

Draw SP for the horizon, parallel to AD , and, through the middle point g of AD , draw OS perpendicular to AD and SP .—Make S the point of sight, and O the place of the observer's eye.

Take SP equal to SO , and P shall be the true point of distance.—Draw AS and DS to the point of sight, and AP to the point of distance, intersecting DS in C : then draw BC parallel to AD , and the outlines of the

D

reti-

reticulated square $A B C D$ will be finished.

From the division-points e, g, i , draw the straight lines ef, gb, ik , tending toward the point of sight S ; and draw BD for one of the diagonals of the square, the other diagonal AC being already drawn.

Through the points r and s , where these diagonals cut ef and ik , draw lm parallel to AD . Through the center-point x , where the diagonals cut gb , draw no parallel to AD .—Lastly, through the points v and w , where the diagonals cut cf and ik , draw pq parallel to AD ; and the reticulated perspective square will be finished.

This square is truly represented, as if seen by an observer standing at O ,
and

and having his eye above the horizontal plane $ABCD$ on which it is drawn; as if OS was the height of his eye above that plane: and the lines which form the small squares within it have the same letters of reference with those in Fig. 4. which is drawn as it would appear to an eye placed perpendicularly above its center x .

OPERATION IV.

To put a Circle in Perspective.

18. If a circle be viewed by an eye placed directly over its center, it appears perfectly round, as Fig. 2. but if it be obliquely viewed, it appears of an elliptical shape, as Fig. 3. This

is plain by looking at a common wine-glass set upright on a table.

19. Make a true reticulated square, as Fig. 4. of Plate II. of the same diameter as you would have the circle; and setting one foot of your compasses in the center x , describe as large a circle as the sides of the square will contain. Then, having put this reticulated square into perspective, as in Fig. 5. observe through what points of the cross lines and diagonals of Fig. 4. the circle passes; and through the like points in Fig. 5. draw the ellipsis, which will be as true a perspective representation of the circle, as the square in Fig. 5. is of the square in Fig. 4.

OPERATION V.

*To put a reticulated Square in Perspective,
as seen by a Person not standing right
against the Middle of either of its Sides,
but rather nearly even with one of its
Corners.*

20. In Fig. 6. of Plate II. let O be the place of an observer, viewing the square $ABCD$ almost even with its corner D .—Draw at pleasure SP for the horizon, parallel to AD , and make SO perpendicular to SP : then, S shall be the point of sight; and P the true point of distance, if SP be made equal to SO .

Draw AS and DS to the point of sight, and AP to the point of distance,

intersecting DS in the point C ; then draw BC parallel to AD , and the outlines of the perspective square will be finished. This done, draw the lines which form the lesser squares, as taught in *Oper. III.* and the work will be completed.—You may put a perspective circle in this square by the same rule as it was done in Fig. 5.

OPERATION VI.

To put a Cube in Perspective, as if viewed by a Person standing almost even with one of its Edges, and seeing three of its Sides.

21. In Fig. 7. of Plate II. let AB be the breadth of either of the six equal square sides of the cube AG ; O the place of the observer, almost even with

with the edge CD of the cube, S the point of fight, SP the horizon parallel to AD , and P the point of distance taken as before.

Make $ABCD$ a true square; draw BS and CS to the point of fight, and BP to the point of distance, intersecting CS in G .—Then draw FG parallel to BC , and the uppermost perspective square side $BFGC$ of the cube will be finished.

Draw DS to the point of fight, and AP to the point of distance, intersecting DS in the point I : then draw GI parallel to CD ; and, if the cube be an opaque one, as of wood or metal, all the outlines of it will be finished; and then it may be shaded as in the figure.

But if you want a perspective view of a transparent glass cube, all the sides of which will be seen; draw AH toward the point of sight, FH parallel to BA , and HI parallel to AD : then $AHID$ will be the square base of the cube, perspective parallel to the top $BFGC$; $ABFH$ will be the square side of the cube parallel to $CGID$, and $FGIH$ will be the square side parallel to $ABCD$.

As to the shading part of the work, it is such mere childrens' play, in comparison of drawing the lines which form the shape of any object, that no rules need be given for it. Let a person sit with his left side toward a window, and he knows full well, that if any solid body be placed on a table before him, the light will fall on the
left.

left-hand side of the body, and the right-hand side will be in the shade.

OPERATION VII.

*To put a Square Pavement in Perspective, consisting of any given Square Number * of equal black and white Square Pieces of Marble, and viewed by a Person standing at a Distance from it, almost even with one of its Corners.*

22. In Fig. 1. of Plate III. let SP be the horizon, SO perpendicular to SP , O the place of the observer, viewing the square black and white marble pavement $ABCD$, nearly even with the corner D ; S the point of sight, P

* A *square number* is the product of any given number multiplied by itself. Thus, 144 is the square of 12; for 12 times 12 is 144; and 256 is the square of 16.

the point of distance (§ 12.), and the side AD be parallel to SP .

Suppose the side AD (equal to the breadth of the pavement) to be 16 feet, and that each square piece of marble in the pavement is a foot broad; then the whole pavement will contain 256 of these square pieces; for 16 times 16 is 256; that is, 256 is the square of 16.

Divide AD into 16 equal parts, as $Ab, bc, cd, \&c.$ and from these points of division, $b, c, d, \&c.$ draw straight lines to the point of sight S .

From P the point of distance draw the straight line PD , intersecting AS in the point B ; then, from B draw BC parallel to AD , which will complete the outlines of the perspective square pavement $ABCD$.

Through

Through the points where the diagonal BD intersects the lines drawn from b, c, d, e , &c. toward the point of sight S , draw straight lines parallel to AD (as in *Oper.* III. and V.) and you will have divided the square pavement $ABCD$ into 256 lesser squares; one half of which may be shaded black, and the other half left white, to represent the 256 square pieces of black and white marble which compose the pavement.

OPERATION VIII.

To put an oblong Square Pavement in Perspective, whose Length is equal to any given Number of Times its Breadth.

23. In Fig. 1. of Plate III. suppose the given length DF or AE to be 32 feet,

feet, and the given breadth AD to be 16. We have already got half the given length DC , in the perspective square $ABCD$; and such another added to it will complete the perspective figure of the pavement.

To the right hand top-corner C of the square $ABCD$, draw the straight line PC from the point of distance P , intersecting AS at E : from the point E draw EF parallel to AD , and the outlines of the second square $BEFC$ will be completed; which, as in the figure, may be divided into 256 lesser squares, by the same method that $ABCD$ was so divided: and then, in perspective, the length of the oblong square pavement $Aefd$ will be twice as great as its breadth; and the whole will contain 512 lesser squares.

24. If the given length be equal to three times the breadth, we must have a third perspective square $EGHF$ joined to the top of the second square $BEFC$.

From the point of distance P , draw the straight line PF to the right hand top-corner F of the second square, and intersecting AS at G : then, from the point G draw GH parallel to AD , which will complete the third perspective square $EGHF$.—This square (like the former two) may be subdivided into 256 lesser squares; and then we shall have an oblong square pavement $AGHD$, whose perspective length is equal to three times its breadth, and divided into 768 lesser squares.

25. And

25. And thus (as is plain by the figure) you may proceed, and make as many more perspective squares (*GIKH, ILMK, LNOM, &c.*) as you please.—There are ten such squares in this figure; and if we suppose each of them to be 16 feet broad, and paved with black and white marble as *ABCD* is, the whole pavement, being ten times as long as it is broad, will contain 2560 square feet of marble surface.

OPERATION IX.

To put a Square Pyramid in Perspective, as if standing upright on its base, and viewed obliquely.

26. In Fig. 2. of Plate III. let *AD* be the breadth of either of the four sides
 8 of

of the pyramid $ATCD$ at its base $ABCD$; and MT its perpendicular height. Let O be the place of the observer, S his point of sight, SE his horizon, parallel to AD and perpendicular to OS ; and let the proper point of distance be taken in SE produced toward the left hand, as far from S as O is from S .

Draw AS and DS to the point of sight, and DL to the point of distance, intersecting AS in the point B . Then, from B , draw BC parallel to AD ; and $ABCD$ shall be the perspective square base of the pyramid.

Draw the diagonal AC , intersecting the other diagonal BD at M , and this point of intersection shall be the center of the square base.

Draw

Draw MT perpendicular to AD , and of a length equal to the intended height of the pyramid: then draw the straight lines AT , CT , and DT ; and the outlines of the pyramid (as viewed from O) will be finished; which being done, the whole may be so shaded as to give it the appearance of a solid body.

If the observer had stood at o , he could have only seen the side ATD of the pyramid; and two is the greatest number of sides that he could see from any other place of the ground. But if he were at any height above the pyramid, and had his eye directly over its top, it would then appear like Fig. 3. and he would see all its four sides E , F , G , H , with its top t just over the center of its square base $ABCD$;
which

which would be a true geometrical, and not a perspective, square.

OPERATION X.

To put two equal Squares in Perspective, one of which shall be directly over the other, at any given Distance from it, and both of them parallel to the Plane of the Horizon.

27. In Fig. 4. of Plate III. let $ABCD$ be a perspective square on a horizontal plane, drawn according to the foregoing rules (§ 16), S being the point of sight, SP the horizon (parallel to AD), and P the point of distance.

Suppose AD , the breadth of this square, to be three feet; and that it is required to place just such another

E square

square $EFGH$ directly above it, parallel to it, and two feet from it.

Make AE and DH perpendicular to AD , and two thirds of its length: draw EH , which will be equal and parallel to AD ; then draw ES and HS to the point of sight S , and EP to the point of distance P , intersecting HS in the point G : this done, draw FG parallel to EH ; and you will have two perspective squares $ABCD$ and $EFGH$, equal and parallel to one another, the latter directly above the former, and two feet distant from it; as was required.

By this method, shelves may be drawn, parallel to one another, at any distance from each other in proportion to their length.

OPERATION XI.

To put a Square Table in Perspective, standing on four upright Square Legs of any given Length with respect to the Breadth of the Table.

28. In Fig. 4. of Plate III. let $ABCD$ be the square part of the floor on which the table is to stand, and $EFGH$ the surface of the square table, parallel to the floor.

Suppose the table to be three feet in breadth, and its height from the floor to be two feet; then, two thirds of AD or EH will be the length of the legs i and k ; the other two (l and m) being of the same length in perspective.

Having drawn the two equal and parallel squares $ABCD$ and $EFGH$, as shewn in *Oper.* X. let the legs be square in form, and fixed into the table at a distance from its edges equal to their thicknesses. Take Aa and Dd equal to the intended thicknesses of the legs, and ab and dc also equal thereto. Draw the diagonals AC and BD , and draw straight lines from the points a, b, c, d , toward the point of sight S , and terminating at the side BC . Then, through the points where these lines cut the diagonals, draw the straight lines n and o , p and q , parallel to AD ; and you will have formed four perspective squares (like $ABCD$ in Fig. 2.) for the bases of the four legs of the table: and then it is easy to draw the four upright legs by parallel lines, all perpendicular to AD ;

AD ; and to shade them as in the figure.

To represent the intended thickness of the table-board, draw eb parallel to EH , and HG toward the point of sight S : then shade the spaces between these lines, and the perspective figure of the table will be finished.

OPERATION XII.

To put an oblong Square Table in Perspective, of any given Length with respect to its Breadth.

29. Suppose the given length to be four feet, and the breadth to be three. —In Fig. 6. of Plate II. let AD be the length, and divide it into four equal parts Ae , eg , gi , iD : draw AS and

E 3

DS

DS to the point of fight S ; and AP to the point of distance P .

From the point i , which is three fourths of AD , draw is toward the point of fight, till it meets the diagonal AC in s : then, through that point of meeting, draw lm parallel to AD ; and you will have an oblong square $AlmD$, whose breadth Al or Dm is perspectively equal to three quarters of its length AD .

30. Let the breadth of the table be equal to half its length AD .—From g , the middle point between A and D , draw gx toward the point of fight S , till it meets the diagonal AC in the point x ; then, through the point x , draw no parallel to AD , and you will have an oblong square $AnoD$, whose
length

length AD is equal to twice its breadth An or Da .

31. Suppose the length to be equal to four times the breadth.—From e , a fourth part of the distance between A and D , draw ev toward the point of sight S , till it meets the diagonal AC at v ; then, through that point of meeting, draw pq parallel to AD , and you will have an oblong square $ApqD$, whose length AD is four times as great as its perspective breadth Ap or Dq .

In this manner you may make the breadth bear any proportion to the length that you please; and may put legs to the table as shewn in *Oper. XI*.

OPERATION XIII.

*To put five Square Pyramids in Perspective,
standing upright on a Square Pavement
composed of the Surfaces of 81 Cubes.*

32. In Fig. 1. of Plate IV. let $ABCD$ be a perspective square drawn according to the foregoing rules; S the point of sight, P the point of distance in the horizon PS , and AC and BD the two diagonals of the square.

Divide the side AD into 9 equal parts (because 9 times 9 is 81) as Aa , ab , bc , &c. and from these points of division, a , b , c , d , &c. draw lines toward the point of sight S , terminating at the furthestmost side BC of the square. Then, through the points where

where these lines cut the diagonals, draw straight lines parallel to AD (as in *Oper.* III.), and the perspective square $ABCD$ will be subdivided into 81 lesser squares, representing the upper surfaces of 81 cubes, laid close to one another's sides, in a square form.

Draw AK and DL , each equal to Aa , and perpendicular to AD ; and draw LN toward the point of sight S : then draw KL parallel to AD , and its distance from AD will be equal to Aa .—This done, draw al , bm , cn , do , ep , fq , gr , and hs , all parallel to AK ; and the space $ADLK$ will be subdivided into nine equal squares, which are the outer upright surfaces of the nine cubes in the side AD of the square $ABCD$.

Draw

Draw LN toward the point of sight S ; and from the points where the lines, which are parallel to AD in this square, meet the side CD thereof, draw short lines to LN , all parallel to DL , and they will divide that side into the outer upright surfaces of the nine cubes which compose it: and then the outsides of all the cubes that can be visible to an observer, placed at a proper distance from the corner D of the square, will be finished.

As taught in *Oper.* IX. place the pyramid AE upright on its square base $Atva$, making it as high as you please; and the pyramid DH on its square base $buwD$, of equal height with AE .

Draw EH from the top of one of these pyramids to the top of the other;

other; and EH will be parallel to AD .

Draw ES and HS to the point of sight S , and HP to the point of distance P , intersecting ES in F .

From the point F , draw FG parallel to EH ; then draw EG , and you will have a perspective square $EFGH$ (parallel to $ABCD$) with its two diagonals EG and FH , intersecting one another in the center of the square at I . The four corners of this square, E, F, G, H , give the perspective heights of the four pyramids AE, BF, CG , and DH ; and the intersection I of the diagonals gives the height of the pyramid MI , the center of whose base is the center of the perspective square $ABCD$.

Lastly,

Lastly, place the three pyramids BF , CG , MI , upright on their respective bases at B , C , and M ; and the required perspective representation will be finished, as in the figure.

OPERATION XIV.

To put upright Pyramids in Perspective, on the Sides of an oblong Square or Parallelogram; so that their Distances from one another shall be equal to the Breadth of the Parallelogram.

In most of the foregoing operations, we have considered the observer to be so placed, as to have an oblique view of the perspective objects: in this, we shall suppose him to have a direct view of Fig. 2. Plate IV. that is, stand-
ing

ing right against the middle of the end AD which is nearest to his eye, and viewing AD under an angle of 60 degrees. § 10.

Having cut AD in the middle, by the perpendicular line Ss , take S therein at pleasure for the point of sight, and draw ES for the horizon, parallel to AD .—Here Ss must be supposed to be produced downward, below the limits of the plate, to the place of the observer; and SE to be produced towards the left hand beyond E , far enough to take a proper point of distance therein, according to the foregoing rules.

Take Ad at pleasure, and Dg equal to Ad , for the breadths of the square bases of the two pyramids AE and DF

DF next the eye: then draw AS and dS , and likewise DS and gS , to the point of sight S ; and DG on to the point of distance, intersecting AS in G : then, from G draw GI parallel to AD , and you will have the first perspective square $AGID$ of the parallelogram $ABCD$.

From I draw IH to (or toward) the point of distance, intersecting AS in H : then, from H draw HK , parallel to AD , and you will have the second perspective square $GHKI$ of the parallelogram.—Go on in this manner (which is the same with the method demonstrated in *Oper. I.*) till you have drawn as many perspective squares up toward S as you please.

Through the point e , where DG intersects gS , draw bf parallel to AD ;
and

and you will have formed the two perspective square bases $Abcd$ and $efDg$ of the two pyramids at A and D .

From the point f (the upper outward corner of $efDg$) draw fb toward the point of distance, till it meets AS in b ; then, from this point of meeting, draw bm parallel to GI , and you will have formed the two perspective squares $Ghik$ and $lmIn$, for the square bases of the two pyramids at G and I .

Proceed in the same manner to find the bases of all the other pyramids, at the corners of the rest of the perspective squares in the parallelogram $ABCD$, as shewn by the figure.— Then,

Having

Having placed the first two pyramids at *A* and *D* upright on their square bases, as shewn in *Oper.* IX. and made them of any equal heights at pleasure, draw *ES* and *FS* from the tops of these pyramids to the point of sight *S*: place all the rest of the pyramids upright on their respective bases, making their tops touch the straight lines *ES* and *FS*; and all the work, except the shading part, will be finished.

33. *Remark.*—It must be acknowledged, that there is something in this figure not quite agreeable to the eye; which is, that the two pyramids at *G* and *I* seem to be too far from those at *A* and *D*, when compared with the distances between the rest.—But this arises from their being viewed
(in

(in the figure) at a greater distance than the observer is supposed to be at from the point of sight *S*; which is but 7 inches and three fourths of an inch, in viewing *AD* under an angle of 60 degrees: whereas, in viewing the figure, we seldom bring the paper within less than a foot from the eye. —But, if a person who looks at the figure will place his eye directly over the point of sight *S*, so that an imaginary line $7\frac{3}{4}$ inches long, from the point of sight, and perpendicular to the surface of the paper, shall touch his eye; the disagreeable idea will vanish, and the representation will appear natural.

On which it may be proper to observe, that, when people look at perspective drawings, they generally keep

F

their

their eye at a greater distance than what would form an angle of 60 degrees with the boundaries of the object; and therefore they see it under an angle considerably less than 60 degrees. And, for this reason, it may be proper to inform the learner, that, in drawing perspective representations of objects, he had better put his supposed observer's station so far from the side *AD* next his eye, that it may not subtend an angle of more than 45 degrees, or 50 at most: and then the drawings will have a much more agreeable appearance.

It is true, that this caution, though generally necessary, is attended in practice with a small inconvenience: which is, that as the point of distance must always be placed as far from the
point

point of sight as the observer is supposed to be from it, the schemes, though but small, must be drawn on large paper; otherwise the point of distance may fall without the limits of the paper; as it does even in this figure (Fig. 2.), on account of the breadth thereof from *A* to *D*, although it is drawn as if viewed under an angle of 60 degrees.—But this is of very little moment, as it is easy to fix a long slip of paper by two wafers to the edge of that on which any scheme is drawn; so that the horizon-line may be extended out on that slip, to find the point of distance therein, as far from the point of sight as you please.

OPERATION XV.

To put a Rummer or Drinking-Glass in Perspective.

34. According to the foregoing method (*Oper. X.*) draw the two equal and parallel perspective squares *ABCD* and *EFGH* in Fig. 3. of Plate IV. the latter directly above the former. Then, as in *Oper. IV.* put a perspective circle in the lowermost square for the bottom of the cup, and one in the uppermost for the top or brim thereof, and draw out the rest of the figure in whatever shape you please.

OPERATION XVI.

*To put a Square Pyramid of equal sized
Cubes in Perspective.*

35. Fig. 2. of Plate V. represents a pyramid of this kind; consisting (as it were) of square tables of cubes, one table above another; 81 in the lowest, 49 in the next, 25 in the third, 9 in the fourth, and 1 in the fifth or uppermost. These are the square numbers of 9, 7, 5, 3, and 1.

If the artist is already master of all the preceding operations, he will find less difficulty in this than in attending to the following description of it: for it cannot be described in a few words, but may be executed in a very short time.

In Fig. 1. having drawn PS for the horizon, and taken S for the point of sight therein (the observer being at O) draw AD parallel to PS for the side (next the eye) of the first or lowermost table of cubes. Draw AS and DS to the point of sight S , and DP to the point of distance P , intersecting AS in the point B . Then, from B , draw BC parallel to AD , and you will have the surface $ABCD$ of the first table.

Divide AD into nine equal parts, as Aa , ab , bc , cd , &c. then make AK and DL equal to Aa , and perpendicular to AD . Draw KL parallel to AD , and from the points of equal division at a , b , c , &c. draw lines to KL , all parallel to AK . Then draw bS to the point of sight S , and from

the

the division-points a, b, c , &c. draw lines with a black lead pencil, all tending toward the point of sight, till they meet the diagonal BD of the square.

From these points of meeting draw black lead lines to DC , all parallel to AD ; then draw the parts of these lines with black ink which are marked 1, 2, 3, 4, &c. between bE and DC .

Having drawn the first of these lines βq with black ink, draw the parts ai, bk, cl , &c. (of the former lines which met the diagonal BD) with black ink also; and rub out the rest of the black lead lines, which would otherwise confuse the following part of the work. Then, draw LF toward the
F 4 point

point of fight S ; and, from the points where the lines 1, 2, 3, 4, &c. meet the line DC , draw lines down to LF , all parallel to DL ; and all the visible lines between the cubes in the first table will be finished.

Make iG equal and perpendicular to βi , and qM equal and parallel to iG : then draw GM , which will be equal and parallel to iq . From the points k, l, m, n , &c. draw kn, lo, mp , &c. all parallel to iG , and the outsides of the seven cubes in the side Gq of the second table will be finished.

Draw GS and MS to the point of fight S , and MP to the point of distance P , intersecting GS in H ; then, from the point of intersection H , draw HI parallel to AD ; and you will
have

have the surface $GHIM$ of the second table of cubes.

From the points n, o, p, q , &c. draw black lead lines toward the point of sight S , till they meet the diagonal MH of the perspective square surface $GHIM$; and draw sN , with black ink, toward the point of sight.

From those points where the lines drawn from n, o, p, q , &c. meet the diagonal MH , draw black lead lines to MI , all parallel to AD ; only draw the whole first line γI with black ink, and the parts 2, 3, 4, &c. and nt, ou, pv , &c. of the other lines between γN and MI , and GM and γI , with the same; and rub out all the rest of the black lead lines, to avoid further confusion. Then, from the points where
the

the short lines 1, 2, 3, &c. meet the line MI , draw lines down to qE , all parallel to Mq , and the outer surfaces of the seven cubes in the side ME will be finished; and all these last lines will meet the former parallels 2, 3, 4, &c. in the line qE .

Make tO equal and perpendicular to γt , and yP equal and parallel to tO ; then draw OP , which will be equal and parallel to ty .—This done, draw OS and PS to the point of sight S , and PP to the point of distance P in the horizon. Lastly, from the point Q , where PP intersects OS , draw QR parallel to OP ; and you will have the outlines $OQRP$ of the surface of the third perspective table of cubes.

From the points u, v, w, x , draw upright lines to OP , all parallel to tO ,
and

and you will have the outer surfaces of the five cubes in the side Oy of this third table.

From the points where these upright lines meet OP , draw lines toward the point of sight S , till they meet the diagonal PQ ; and from these points of meeting draw lines to PR , all parallel to OP , making the parts 2, 3, 4, 5, of these lines with black ink which lie between Zr and PR . Then, from the points where these lines meet PR , draw lines down to yN ; which will bound the outer surfaces of the five cubes in the side PN of the third table.

Draw the line δi with black ink; and, at a fourth part of its length between δ and Z , draw an upright line
to

to S , equal in length to that fourth part, and another equal and parallel thereto from Z to V : then draw SV parallel to δZ , and draw the two upright and equidistant lines between δZ and SV , and you will have the outer surfaces of the three cubes in the side SZ of the fourth table.

Draw SS and VS to the point of sight S in the horizon, and VP to the point of distance therein, intersecting SS in T ; then draw TU parallel to SV , and you have $STUV$, the surface of the fourth table; which being reticulated or divided into 9 perspective small squares, and the uppermost cube W placed on the middlemost of the squares, all the outlines will be finished; and when the whole is properly shaded, as in Fig. 2. the work will be done.

O P E R A-

OPERATION XVII.

To represent a double Cross in Perspective.

36. In Fig. 3. of Plate V. let $ABCD$ and $EFGH$ be two perspective squares, equal and parallel to one another, the uppermost directly above the lowermost, drawn by the rules laid down in *Oper. X.* and as far asunder as is equal to the given height of the upright part of the cross; S being the point of sight, and P the point of distance, in the horizon PS taken parallel to AD .

Draw AE , DH , and CG ; then, $AEHD$ and $DHGC$ shall be the two visible sides of the upright part of the cross; of which, the length AE is
here

here made equal to three times the breadth EH .

Divide DH into three equal parts, HI , IK , and KD . Through these points of division, at I and K , draw MO and PR parallel to AD ; and make the parts MN , IO , PQ , KR , each equal to HI : then draw MP and OR parallel to DH .

From M and O , draw MS and OS to the point of sight S ; and from the point of distance P draw PN cutting MS in T : from T draw TU parallel to MO , and meeting OS in U ; and you will have the uppermost surface $MTUO$ of one of the cross pieces of the figure.
 —From R , draw RS to the point of sight S ; and from U , draw UV parallel to OR ; and $OUVR$ shall be the perspective

perspective square end next the eye of that cross-part.

Draw PMx (as long as you please) from the point of distance P , through the corner M ; lay a ruler to N and S , and draw XN from the line Px :—then lay the ruler to I and S , and draw YZS .—Draw XY parallel to MO , and make XW and YB equal and perpendicular to XY : then draw WB parallel to XY , and $WXYB$ shall be the square visible end of the other cross-part of the figure.

Draw BK toward the point of sight S ; and from U draw UP to the point of distance P , intersecting YS in Z : then, from the intersection Z , draw Za parallel to MO , and Zb parallel to HD , and the whole delineation will be finished.

This

This done, shade the whole, as in Fig. 4. and you will have a true perspective representation of a double cross.

OPERATION XVIII.

To put three Rows of upright Square Objects in Perspective, equal in Size, and at equal Distances from each other, on an oblong Square Plain, the Breadth of which shall be of any assigned Proportion to the Length thereof.

37. Fig. 2. of Plate VI. is a perspective representation of an oblong square plain, three times as long as it is broad, having a row of nine upright square objects on each side, and one of the same number in the middle; all equally high, and at equal distances from

one another, both long-wise and cross-wise, on the same plane.

In Fig. 1. PS is the horizon, S the point of sight, P the point of distance, and AD (parallel to PS) the breadth of the plain.

Draw AS , NS , and DS , to the point of sight S ; the point N being in the middle of the line AD : and draw DP to the point of distance P , intersecting AS in the point B : then, from B draw BC parallel to AD , and you have the perspective square $ABCD$.

Through the point i , where DB intersects NS , draw ae parallel to AD ; and you will have subdivided the perspective square $ABCD$ into four lesser

fer squares, as $A a i N$, $N i e D$, $a B k i$,
and $i k C e$.

From the point C (at the top of the perspective square $ABCD$) draw CP to the point of distance P , intersecting AS in E ; then, from the point E draw EF parallel to AD ; and you will have the second perspective square $BEFC$.

Through the point l , where CE intersects NS , draw bf parallel to AD ; and you will have subdivided the square $BEFC$ into the four squares $B b l k$, $k l f C$, $b E m l$, and $l m F f$.

From the point F (at the top of the perspective square $BEFG$) draw FP to the point of distance P , intersecting AS in I ; then, from the point I draw

IK

IK parallel to AD ; and you will have the third perspective square $EIKF$.

Through the point n , where FI intersects NS , draw cg parallel to AD ; and you will have subdivided the square $EIKF$ into four lesser squares, $Ecnm$, $mngF$, $cIon$, and $noKg$.

From the point K (at the top of the third perspective square $EIKF$) draw KP to the point of distance P , intersecting AS in L ; then, from the point L draw LM parallel to AD , and you will have the fourth perspective square $ILMK$.

Through the point p , where KL intersects NS , draw dh parallel to AD ; and you will have subdivided the square $ILMK$ into the four lesser

squares $Idpo$, $opbK$, $dLqp$, and $pqMb$.

Thus, we have formed an oblong square $ALMD$, whose perspective length is equal to four times its breadth, and it contains 16 equal perspective squares.—If greater length was still wanted, we might proceed further on toward S .

Take $A3$ equal to the intended breadth of the side of the upright square object AQ (all the other sides being of the same breadth) and AO for the intended height. Draw $O18$ parallel to AD , and make $D8$ and 47 equal to $A3$; then draw $3S$, $4S$, $7S$, and $8S$ to the point of sight S ; and among them we shall have the perspective square bases of all the 27 upright objects on the plain.

Through the point 9, where DB intersects $8S$, draw 110 parallel to AD , and you have the three perspective square bases $A123$, 4567 , $8910D$ of the three upright square objects at A , N , and D .

Through the point 21, where eb intersects $8S$, draw 1411 parallel to AD ; and you will have the three perspective squares $a141516$, 17181920 , and $2111e22$, for the bases of the second cross row of objects; namely, the next beyond the first three at A , N , and D .

Through the point w , where CE intersects $8S$, draw a line parallel to BC ; and you will have three perspective squares, at B , k , and C , for the bases of the third row of objects; one of which is set up at B .

Through the point x , where fc intersects $8S$, draw a line parallel to bf ; and you will have three perspective squares, at b , l , and x , for the bases of the fourth cross row of objects.

Go on in this manner, as you see in the figure, to find the rest of the square bases, up to LM ; and you will have 27 upon the whole oblong square plane, on which you are to place the like number of objects, as in Fig. 2.

Having assumed AO for the perspective height of the three objects (at A , N , and D) next the observer's eye, and drawn $O18$ parallel to AD , in order to make the objects at N and D of the same height as that at O ; and having drawn the upright lines 415 , $7W$, $8X$, and $D22$, for the heights

heights N and D ; draw OS and RS ,
 $15S$ and WS , XS and $22S$, all to the
 point of sight S ; and these lines will
 determine the perspective equal
 heights of all the rest of the upright
 objects, as shewn by the two placed
 at a and B .

To draw the square tops of these
 objects, equal and parallel to their
 bases, we need only give one ex-
 ample, which will serve for all.

Draw $3R$ and $2Q$ parallel to AO ,
 and up to the line RS ; then draw
 PQ parallel to OR , and $OPQR$ shall
 be the top of the object at A , equal
 and parallel to its square base $A123$.
 —In the same easy way the tops of
 all the other objects are formed.

When all the rest of the objects are delineated, shade them properly, and the whole perspective scheme will have the appearance of Fig. 2.

OPERATION XIX.

To put a Square Box in Perspective, containing a given Number of lesser Square Boxes, of a Depth equal to their Width.

38. Let the given number of little square boxes or cells be 16, then 4 of them make the length of each side of the four outer sides ab , bc , cd , da , as in Fig. 3. and the depth af is equal to the width ae .—Whoever can draw the reticulated square in *Oper. V.* (Fig. 6. of Plate II.) will be at no loss about putting this perspective scheme in practice.

OPER A-

OPERATION XX.

To put Stairs, with equal and parallel Steps, in Perspective.

39. In Fig. 1. of Plate VII. let ab be the given breadth of each step, and ai the height thereof.—Make bc , cd , de , &c. each equal to ab ; and draw all the upright lines ai , bl , cn , dp , &c. perpendicular to ab (to which the horizon sS is parallel) and from the points i , l , n , p , r , &c. draw the equidistant lines iB , lC , nD , &c. parallel to ab ; these distances being equal to that of iB from ab .

Draw xi , touching all the corner-points l , n , p , r , t , v ; and draw $2\ 16$ parallel

parallel to xi , as far from it as you want the length of the steps to be.

Toward the point of sight S , draw the lines $a\ 1$, $i\ 2$, $k\ 3$, $l\ 4$, &c. and draw $16\ 15$, $14\ 13$, $12\ 11$, $10\ 9$, $8\ 7$, $6\ 5$, $4\ 3$, and $2\ 1$, all parallel to Ab , and meeting the lines $w\ 15$, $u\ 13$, $s\ 11$, &c. in the points 15 , 13 , 11 , 9 , 7 , 5 , 3 , and 1 : then, from these points draw $15\ 14$, $13\ 12$, $11\ 10$, $9\ 8$, $7\ 6$, $5\ 4$, and $3\ 2$, all parallel to ba ; and the outlines of the steps will be finished. From the point 16 , draw $16\ A$ parallel to ba , and $A\ x\ 16$ will be part of the flat at the top of the uppermost step.—This done, shade the work, as in Fig. 2. and the whole will be finished.

OPERATION XXI.

To put Stairs with Flats and Openings in Perspective, standing on a horizontal Pavement of Squares.

40. In Fig. 3. of Plate VII. having made S the point of sight, and drawn a reticulated pavement AB , as directed in *Oper.* III. and done it only with black lead lines, because many of them must be rubbed out again; at any distance from the side AB of the pavement which is nearest to the eye, and at any point where you chuse to begin the stair at that distance, as a , draw Ga parallel to BA , and take ab at pleasure for the height of each step.

Take

Take ab in your compaffes, and fet that extent as many times upward from F to E as is equal to the firft required number of fteps O, N, M, L, K ; and, from thefe points of divifion in EF , draw $1b, 2d, 3f, 4h$, and $E k$, all equidiftant from one another, and parallel to Fa : then draw the equidiftant upright lines ab, td, uf, vh, wk , and Im , all perpendicular to Fa : then draw mb , touching the outer corners of thefe fteps at m, k, h, f, d , and b ; and draw ns parallel to mb , as far from it as you want the length of the fteps K, L, M, N, O to be.

Toward the point of fight S , draw $mn, l5, ko, i6, hp, f2, dr$, and bs . Then (parallel to the bottom-line BA) through the points n, o, p, q, r, s , draw $n8, 514, 615, 716, 117$, and $2s$; which

which done, draw $n\ 5$ and $o\ 6$ parallel to lm , and the outlines of the steps K, L, M, N, O will be finished.

At equal distances with that between the lines marked 8 and 14, draw the parallel lines above, marked 9 10 11 12 and 13; and draw perpendicular lines upward from the points n, o, p, q, r, s , as in the figure.

Make Hm equal to the intended breadth of the flat above the square opening at the left hand, and draw HW toward the point of sight S , equal to the intended length of the flat; then draw WP parallel to Hm , and the outlines of the flat will be finished.

Take the width of the opening at pleasure, as from F to C , and draw

CD

CD equal and parallel to FE .—Draw GH parallel to CD , and the short lines marked 33, 34, &c. just even with the parallel lines 1, 2, &c. From the points where these short lines meet CD , draw lines toward the point of sight S till they meet DE . Then, from the points where the lines 38, 39, 40, &c. of the pavement meet Cy , draw upright lines parallel to CD ; and the lines which form the opening will be finished.

The steps P , Q , R , S , T , and the flat U above the arch V , are done in the same manner with those in Fig. 1. as taught in *Oper.* XX. and the equidistant parallel lines marked 18, 19, &c. are directly even with those on the left-hand side of the arch V , and the upright lines on the right-hand

I

side

fide are equidistant with those on the left.

From the points where the lines 18, 19, 20, &c. meet the right-hand fide of the arch, draw lines toward the point of sight *S*: and from the points where the pavement-lines 29, 30, 31, 32 meet the line drawn from *A* toward the point of sight, draw upright lines toward the top of the arch.

Having done the top of the arch, as in the figure, and the few steps to the right-hand thereof; shade the whole, as in Fig. 4. and the work will be finished.

And it is my opinion, that if the young artist is master of all the preceding

ceding operations, he will understand these two figures better by a bare view, than by any description that can be given of them.

OPERATION XXII.

To put upright conical Objects in Perspective, as if standing on the Sides of an oblong Square, at Distances from one another equal to the Breadth of the Oblong.

41. In Fig. 1. of Plate VIII. the bases of the upright cones are perspective circles inscribed in squares of the same diameter, as shewn in *Oper.* IV. and the cones are set upright on their bases by the same rules as are given in *Oper.* IX. and XIV. for pyramids, which we need not repeat here.

In

In the foregoing operations, we have considered the observer's eye to be above the level of the tops of all the objects, as if he viewed those in Pl. IV. V. VI. and VII. when standing on high ground. In the three figures on Plate VIII. we shall suppose him to be standing on low ground, and the tops of the objects to be above the level of his eye.

In Fig. 1. let AD be the perspective breadth of the oblong square $ABCD$; and let Aa and Dd (equal to Aa) be taken for the diameters of the circular bases of the two cones next the eye, whose intended equal heights shall be AE and DF .

Having made S the point of sight, in the horizon parallel to AD , and
H found

found the proper point of distance therein, draw AS and aS , to contain the bases of the cones on the left-hand side, and DS and dS for those on the right.

Having made the two first cones at A and D of equal height at pleasure, draw ES and FS from their tops to the point of sight, for limiting the perspective heights of all the rest of the cones. Then, according to the directions in *Oper.* XIV. divide the parallelogram $ABCD$ into as many equal perspective squares as you please; find the bases of the cones at the corners of these squares, and make the cones thereon, as in the figure.

If you would represent a cieling, equal and parallel to $ABCD$, supported

ported on the tops of these cones, draw EF ; then, $EFGH$ shall be the cieling, and by drawing ef parallel to EF , you will have the thickness of the floor-boards and beams, which may be what you please.

This shews how any number of equidistant pillars may be drawn of equal heights, to support the cieling of a long room; and how the walls of such a room may be represented in perspective at the backs of these pillars. It also shews how a street of houses may be drawn in perspective.

OPERATION XXIII.

To put a Square Hollow in Perspective, the Depth of which shall bear any assigned Proportion to its Width.

42. Fig. 2. of Plate VIII. is the representation of a square hollow, of which the depth AG is equal to three times its width AD ; and S is the point of sight, over which the observer's eye is supposed to be placed, looking perpendicularly down into it, but not directly over the middle.

Draw AS and DS to the point of sight S ; make ST the horizon, parallel to AD , and produce it to such a length beyond T that you may find a point of distance therein not nearer S than

than if AD was seen under an angle of 60 degrees.

Draw DU to the point of distance, intersecting AS in B : then, from the point B draw BC parallel to AD ; and you will have the first perspective square $ABCD$, equal to a third part of the intended depth.

Draw CV to the point of distance, intersecting AS in E : then, from the point E draw EF parallel to AD ; and you will have the second perspective square $BEFC$; which, added to the former one, makes two-thirds of the intended depth.

Draw FW to the point of distance, intersecting AS in G : then, from the point G draw GH parallel to AD ;

H 3

and

and you will have the third perspective square $EGHF$; which, with the former two, makes the whole depth $AGHD$ three times as great as the width AD , in a perspective view.

Divide AD into any number of equal parts, as suppose 8; and from the division-points a, b, c, d , &c. draw lines toward the point of sight S , and ending at GH . Then, through the points where the diagonals BD, EC, GF cut these lines, draw lines parallel to AD ; and you will have the parallelogram $AGHD$ reticulated or divided into 192 small and equal perspective squares.

Make AI and DM equal and perpendicular to AD : then draw IM , which will be equal and parallel to AD ;

AD ; and draw IS and MS to the point of sight S .

Divide AI , IM , and MD into the same number of equal parts as AD is divided: and from these points of division draw lines toward the point of sight S , ending respectively at GK , KL , and LH .

From those points where the lines parallel to AD meet AG and DH , draw upright lines parallel to AI and DM ; and from the points where these lines meet IK and LM , draw lines parallel to IM : then shade the work, as in the figure.

OPERATION XXIV.

To represent a semicircular Arch in Perspective, as if it were standing on two upright Walls, equal in Height to the Height of the Observer's Eye.

43. After having gone through the preceding operation, this will be more easy by a bare view of Fig. 3. in Plate VIII. than it could be made by any description; the method being so much like that of drawing and shading the square hollow.—We need only mention, that $aTbEA$ and $DFctd$ are the upright walls on which the semicircular arch is built; that S is the point of sight in the horizon Tt , taken in the center of the arch; that d (in Fig. 2.) is the point of
of

of distance; and that the two perspective squares $ABCD$ and $DEFC$ make the parallelogram $AEFD$ of a length equal to twice its breadth AD .

OPERATION XXV.

To represent a Square in Perspective, as viewed by an Observer standing directly even with one of its Corners.

44. In Fig. 1. of Plate IX. let A_9BC be a true square, viewed by an observer standing at some distance from the corner C , and just even with the diagonal C_9 .

Let pSP be the horizon, parallel to the diagonal AB ; and S the point of sight, even with the diagonal C_9 .

Here

Here it will be proper to have two points of distance p and P , equidistant from the point of sight S .

Draw the straight line $1\ 17$ parallel to AB , and draw $A8$ and $B\ 10$ parallel to CS . Take the distance between 8 and 9 in your compasses, and set it off all the way in equal parts from 8 to 1 , and from 10 to 17 .—The line $1\ 17$ should be produced a good way further both to right and left hand from 9 , and divided all the way in the same manner.

From these points of equal division, 8 , 9 , 10 , &c. draw lines to the point of sight S , and also to the two points of distance p and P , as in the figure.

Now it is plain, that $acbg$ is the perspective representation of A_9BC ,
I
viewed

viewed by an observer even with the corner *C* and diagonal *Cg*.—But if there are other such squares lying even with this, and having the same position with respect to the line *1 17*, it is evident that the observer, who stands directly even with the corner *C* of the first square, will not be even with the like corners *G* and *K* of the others; but will have an oblique view of them, over the sides *FG* and *IK* which are nearest his eye: and their perspective representations will be *egf6* and *bki3*, drawn among the lines in the figure: of which, the spaces taken up by each side lie between three of the lines drawn toward the point of distance *p*, and three drawn to the other point of distance *P*.

OPERATION XXVI.

To represent a common Chair, in an oblique View, in Perspective.

45. The original lines to the point of sight S , and points of distance p and P , being drawn as in the preceding operation, chuse any part of the plane, as $lmn\ 13$, on which you would have the chair L to stand.—There are just as many lines (namely two) between l and m or 13 and n , drawn toward the point of distance p , at the left hand, as between l and 13 , or m and n , drawn to the point of distance P on the right: so that lm , mn , $n\ 13$, and $13\ l$, form a perspective square.

From

From the four corners $l, m, n, 13$, of this square raise the four legs of the chair to the perspective perpendicular height you would have them: then make the seat of the chair a square equal and parallel to $lmn13$, as taught in *Oper. X.* which will make the two sides of the seat in the direction of the lines drawn toward the point of distance p , and the fore and back part of the seat in direction of the lines drawn to the other point of distance P . This done, draw the back of the chair leaning a little backward, and the cross bars therein tending toward the point of distance P . Then shade the work as in the figure; and the perspective chair will be finished.

OPERATION XXVII.

To represent an oblong Square Table in an oblique perspective View.

46. In Fig. 1. of Plate IX. M is an oblong square table, as seen by an observer standing directly even with C_9 (see *Oper.* XXV.), the side next the eye being perspectively parallel to the side ac of the square acb_9 .—The fore-mentioned lines drawn from the line $t\ 17$ to the two points of distance p and P , form equal perspective squares on the ground plane.

Choose any part of this plane of squares for the feet of the table to stand upon; as at p, q, r , and s , in direction of the lines op and rs for the
two

two long fides, and ts and qr for the two ends; and you will have the oblong square or parallelogram $qrst$ for the part of the floor or ground-plane whereon the table is to stand: and the breadth of this plane is here taken in proportion to the length as 6 to 10; so that, if the length of the table be ten feet, its breadth will be six.

On the four little perspective squares at q , r , s , and t , place the four upright legs of the table, of what height you please, so that the height of the two next the eye, at o and p , shall be terminated by a straight line uv drawn to the point of distance P . This done, make the leaf M of the table an oblong square, perspective equal and parallel to the oblong square $qrst$
on

on which the feet of the table stands. Then shade the whole, as in the figure, and the work will be finished.

If the line 1 17 was prolonged to the right and left hand, and equally divided throughout (as it is from 1 to 17), and if the lines which are drawn from p and P to the right and left hand sides of the plate were prolonged till they came to the extended line 1 17, they would meet it in the equal points of division. In forming large plans of this sort, the ends of slips of paper may be pasted to the right and left edges of the sheet on which the plan is to be formed.

C H A P.

C H A P. III.

*The Description of a Machine,
by which any Person may delineate the true Perspective Figures of Objects, without having learned any of the preceding Rules.*

47. **F**IG. 2. of Plate IX. is a plane of this machine, and Fig. 3. is a representation of it when made use of in drawing distant objects in perspective. A sketch of it was given me several years ago by the late ingenious Dr. BEVIS, who then told me he had never seen one of the like construction: and as all those to whom I have had the opportunity of shewing it,

it, have told me that they never saw nor heard of such a one before, I have great reason to believe that the Doctor was the inventor of it, although he never made it public.

In order that it may be the easier understood, I have put the letters of reference to the plane (Fig. 2.) in small Italics, and the same letters to the like parts of it in the perspective view (Fig. 3.) in Roman capitals; that the reader may look at them both, as he goes on with the following description.

In Fig. 2. *abef* is an oblong square board, represented by *ABEF* in Fig. 3. *x* and *y* (*X* and *Y*) are two hinges on which the part *cld* (*CLD*) is moveable. This part consists of two
arches

arches or portions of circles $cm l$ (CML) and dnl (DNL) joined together at the top l (L) and at bottom to the cross bar dc (DC) to which one part of each hinge is fixed, and the other part to a flat board, half the length of the board $abef$ ($ABEF$) and glued to its uppermost side. The center of the arch $cm l$ is at d , and the center of the arch dnl is at c .

On the outer side of the arch dnl is a sliding piece n (much like the nut of the quadrant of altitude belonging to a common globe) which may be moved to any part of the arch between d and l : and there is such another slider a on the arch $cm l$, which may be set to any part between c and l .—A thread cpn (CPN) is stretched tight from the center c (C) to the slider n (N),

(*N*), and such another thread is stretched from the center *d* (*D*) to the slider *o* (*O*); the ends of the threads being fastened to these centers and sliders,

Now it is plain, that, by moving these sliders on their respective arches, the intersection *p* (*P*) of the threads may be brought to any point of the open space within the arches.—In the groove *k* (*K*) is a straight sliding bar *i* (*I*) which may be drawn further out, or pushed further in, at pleasure.

To the outer end of this bar *I* (Fig. 3.) is fixed the upright piece *HZ*, in which is a groove for receiving the sliding piece *Q*. In this slider is a small hole *r* for the eye to look through, in using the machine: and
there

there is a long slit in HZ , to let the hole r be seen through when the eye is placed behind it, at any height of the hole above the level of the bar I .

How to delineate the Perspective Figure of any distant Object (or Objects) by means of this Machine.

48. Suppose you wanted to delineate a perspective representation of the house $qsrp$ (which we must imagine to be a great way off, without the limits of the plate) place the machine on a steady table, with the end EF of the horizontal board $ABEF$ toward the house, so that, when the Gothic-like arch $DL C$ is set upright, the middle part of the open space (about P) within it may be even with the house when you place your eye at Z

and look at the house through the small hole *r*. Then fix the corners of a square piece of paper with four wafers on the surface of that half of the horizontal board which is nearest the house; and all is ready for drawing.

Set the arch upright, as in the figure; which it will be when it comes to the perpendicular side *t* of the upright piece *st* fixed to the horizontal board behind *D*. Then place your eye at *Z*, and look through the hole *r* at any point of the house, as *q*, and move the sliders *N* and *O* till you bring the intersection of the threads at *P* directly between your eye and the point *q*: then put down the arch flat upon the paper on the board, as at *ST*, and the intersection
of

of the threads will be at *W*. Mark the point *W* on the paper with the dot of a black lead pencil, and set the arch upright again, as before: then look through the hole *r*, and move the sliders *N* and *O* till the intersection of the threads comes between your eye and any other point of the house, as *p*: then put down the arch again to the paper, and make a pencil-mark thereon at the intersection of the threads, and draw a line from that mark to the former one at *W*; which line will be a true perspective representation of the corner *pq* of the house.

Proceed in the same manner, by bringing the intersection of the threads successively between your eye and other points of the outlines of the house, as *r*, *s*, &c. and put down the

arch to mark the like points on the paper, at the interfection of the threads: then connect these points by straight lines, which will be the perspective outlines of the house. In like manner find points for the corners of the door and windows, top of the house, chimnies, &c. and draw the finishing lines from point to point: then shade the whole, making the lights and shades as you see them on the house itself, and you will have a true perspective figure of it.—Great care must be taken, during the whole time, that the position of the machine be not shifted on the table; and to prevent such an inconvenience, the table should be very strong and steady, and the machine fixed to it, either by screws or clamps.

In

In the same way, a landscape, or any number of objects within the field of view through the arch, may be delineated, by finding a sufficient number of perspective points on the paper, and connecting them by straight or curved lines as they appear to the eye. And as this makes every thing in perspective equally easy, without taking the trouble to learn any of the rules for drawing, the operations must be very pleasing and agreeable. Yet, as science is still more so, we would by all means recommend it to our Readers to learn the rules for drawing particular objects; and to draw landscapes by the eye, for which, I believe, no perspective rules can be given. And although any thing may be very truly drawn in perspective by means of this machine, it cannot be

said

said that there is the least degree of science in going *that* way to work.

The arch ought to be at least a foot wide at bottom, that the eye at *Z* may have a large field of view through it; and the eye should then be, at least, $10\frac{1}{2}$ inches from the intersection of the threads at *P* when the arch is set upright. For, if it be nearer, the boundaries of view at the sides near the foot of the arch will subtend an angle at *Z* of more than 60 degrees, which will not only strain the eye (§ 10.), but will also cause the outermost parts of the drawing to have a disagreeable appearance.—To avoid this, it will be proper to draw back the sliding bar *I*, till *Z* be $14\frac{1}{2}$ inches distant from *P*; and then the whole field of view, through the foot wide arch,

arch, will not subtend an angle to the eye at *Z* of more than 45 degrees; which will give a more easy and pleasant view, not only of all the objects themselves, but also of their representations on the paper whereon they are delineated. So that, whatever the width of the arch be, the distance of the eye from it should be in this proportion: As 12 is to the width of the arch, so is $14\frac{1}{2}$ to the distance of the eye (at *Z*) from it.

If a pane of glass, laid over with gum water, be fixed into the arch, and set upright when dry, a person who looks through the hole *r* may delineate the objects upon the glass which he sees at a distance through and beyond it, and then transfer the delineation to a paper put upon the glass, as mentioned in § 1.

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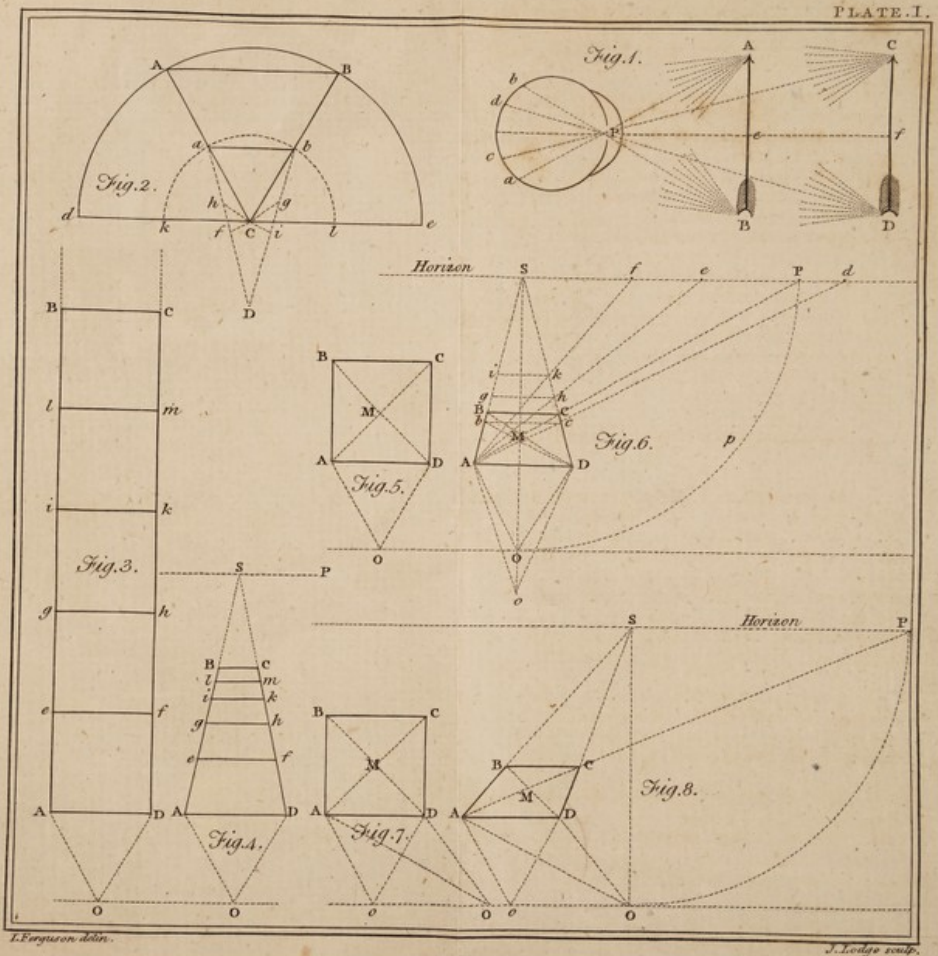
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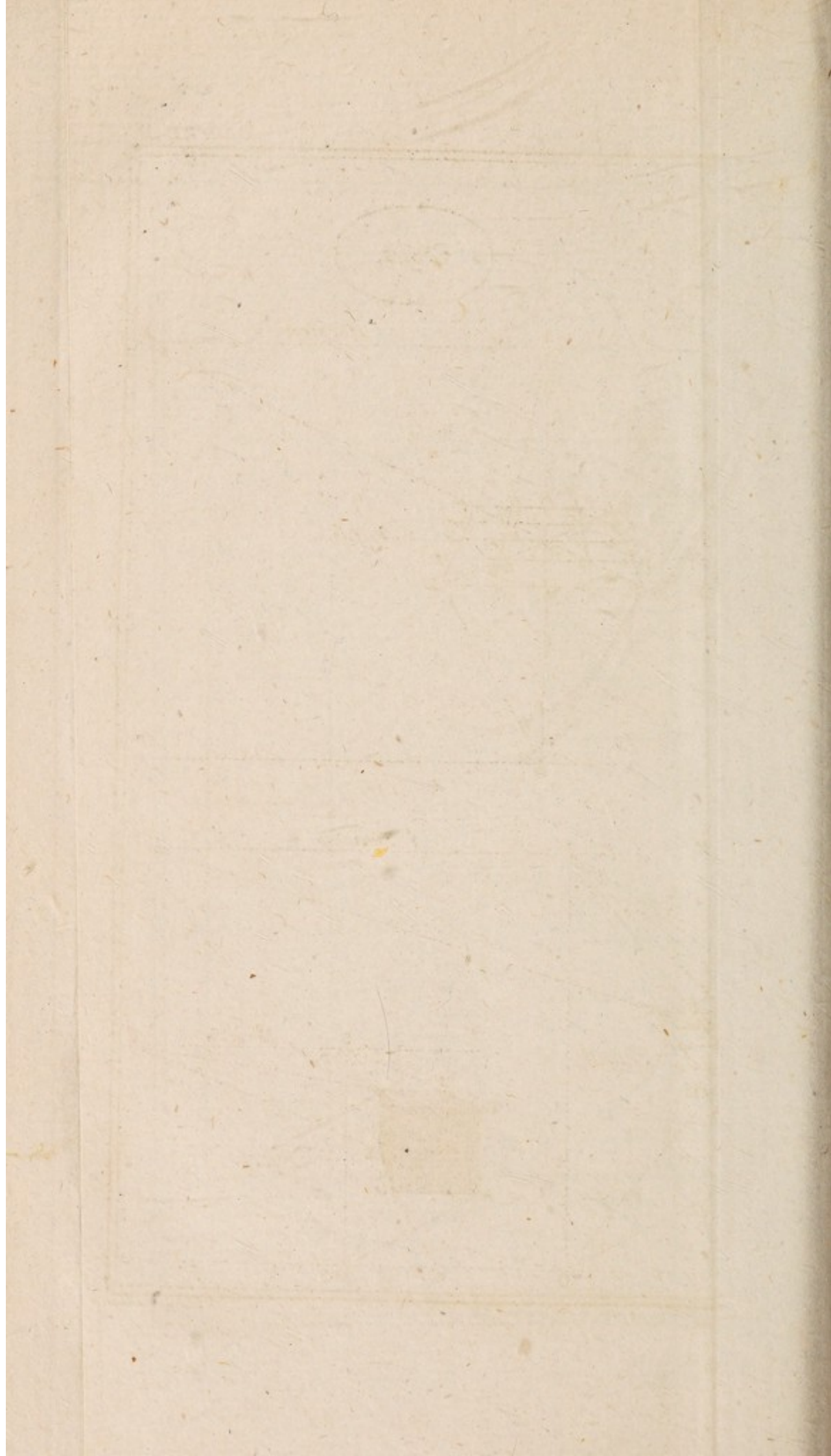
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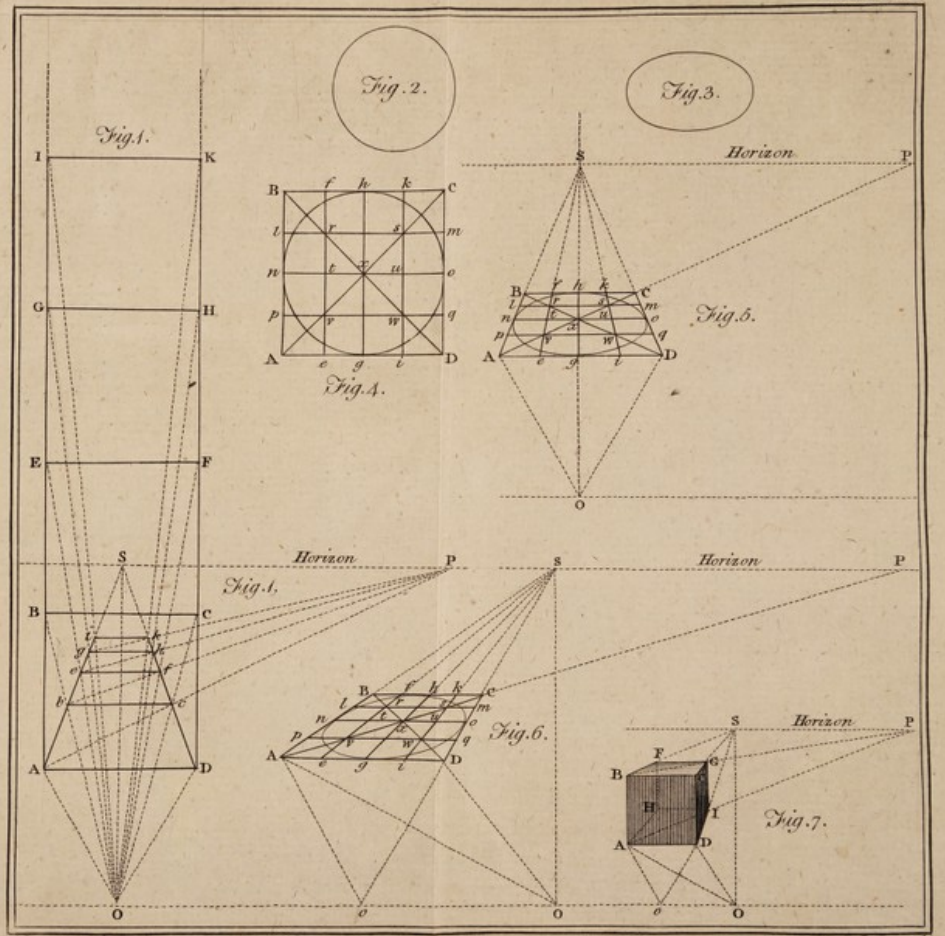
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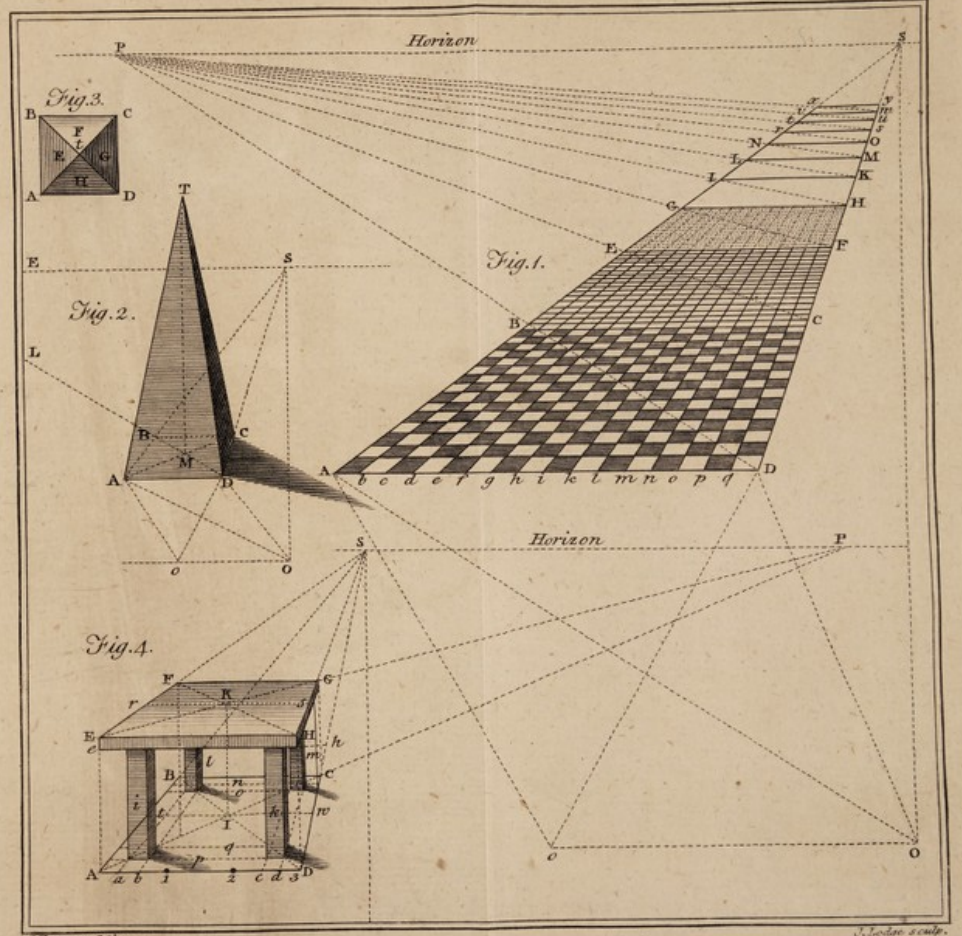


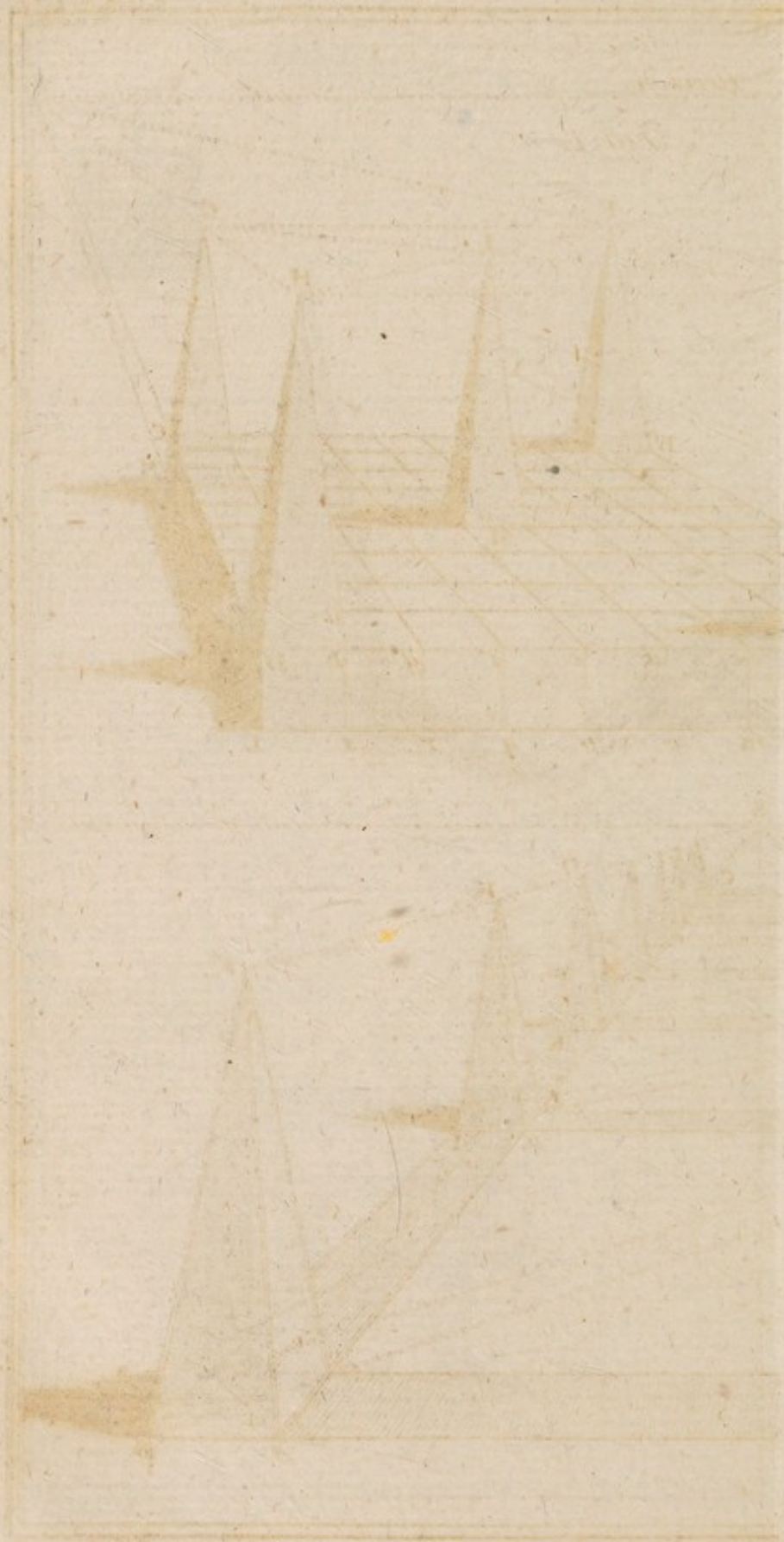


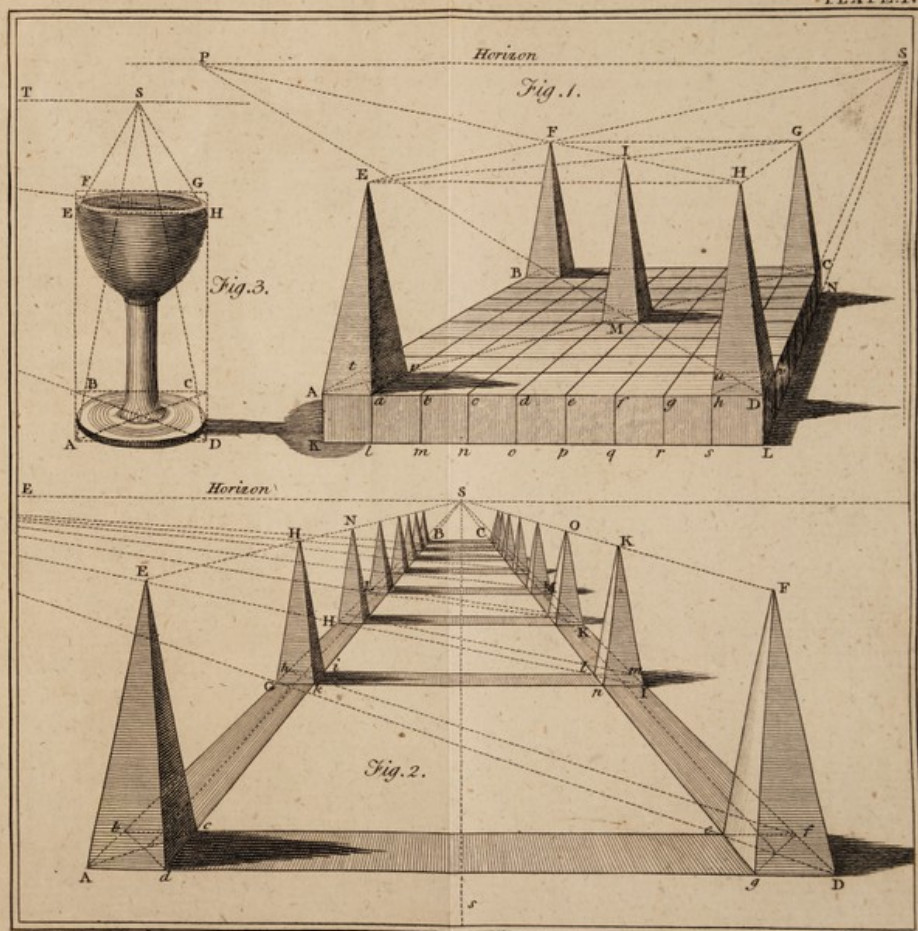
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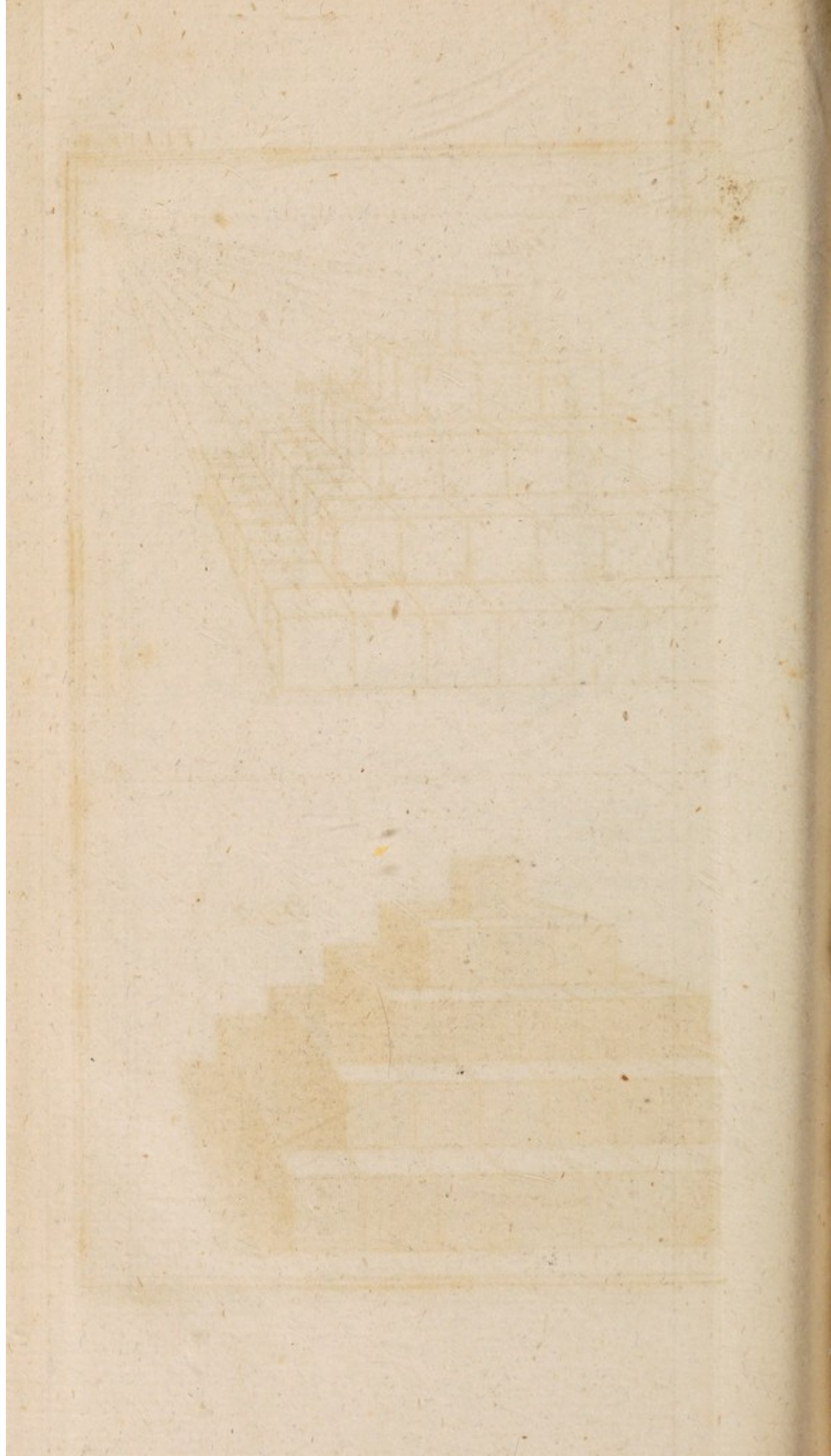


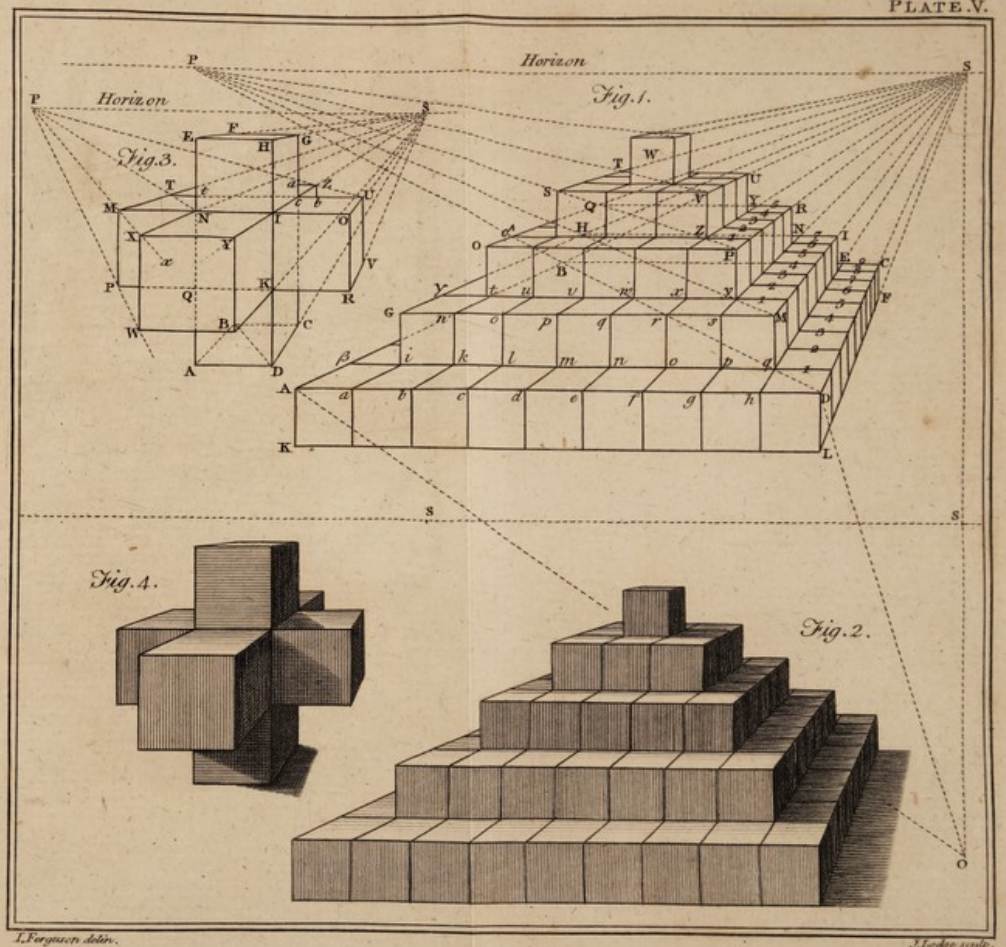




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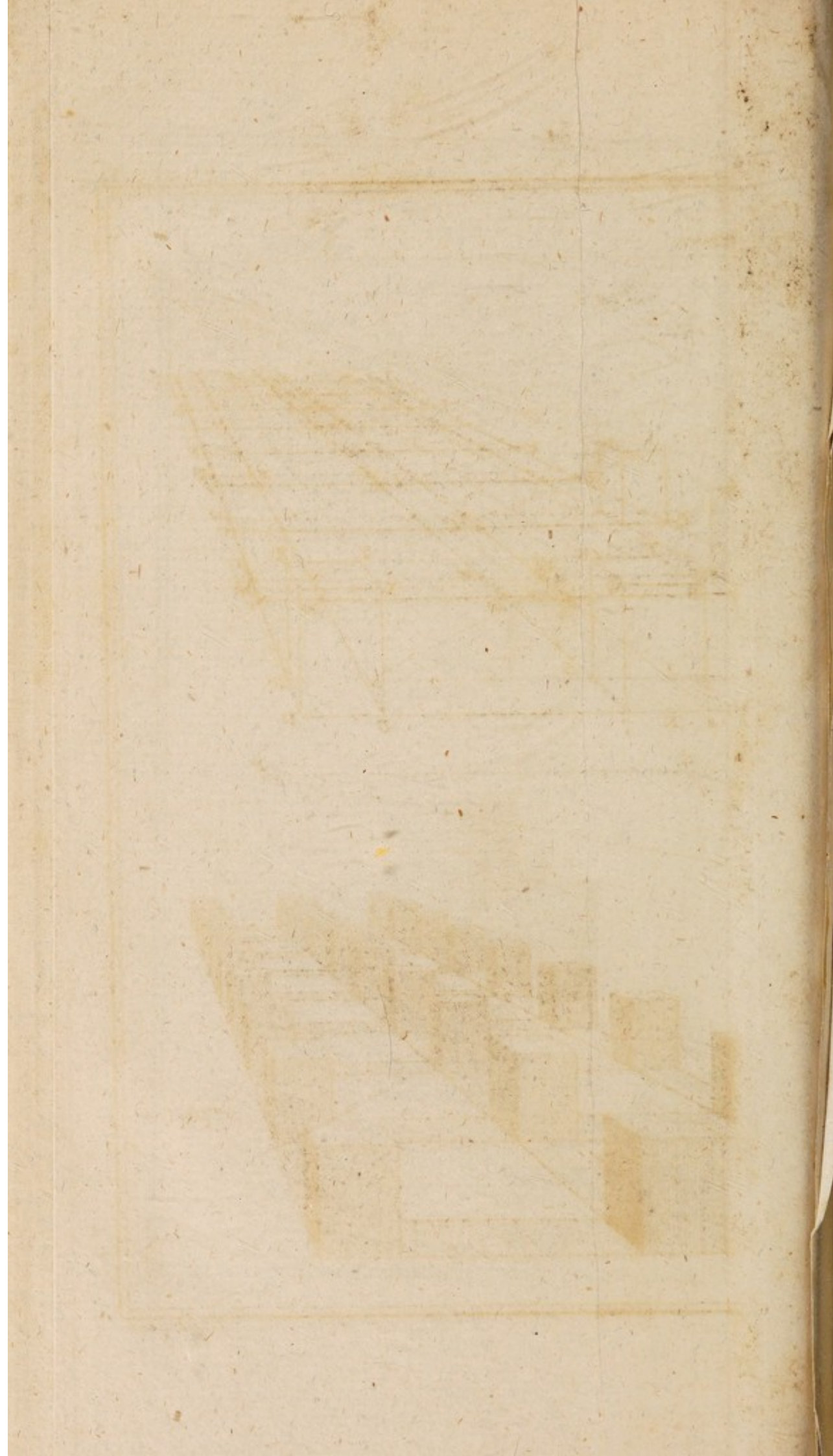
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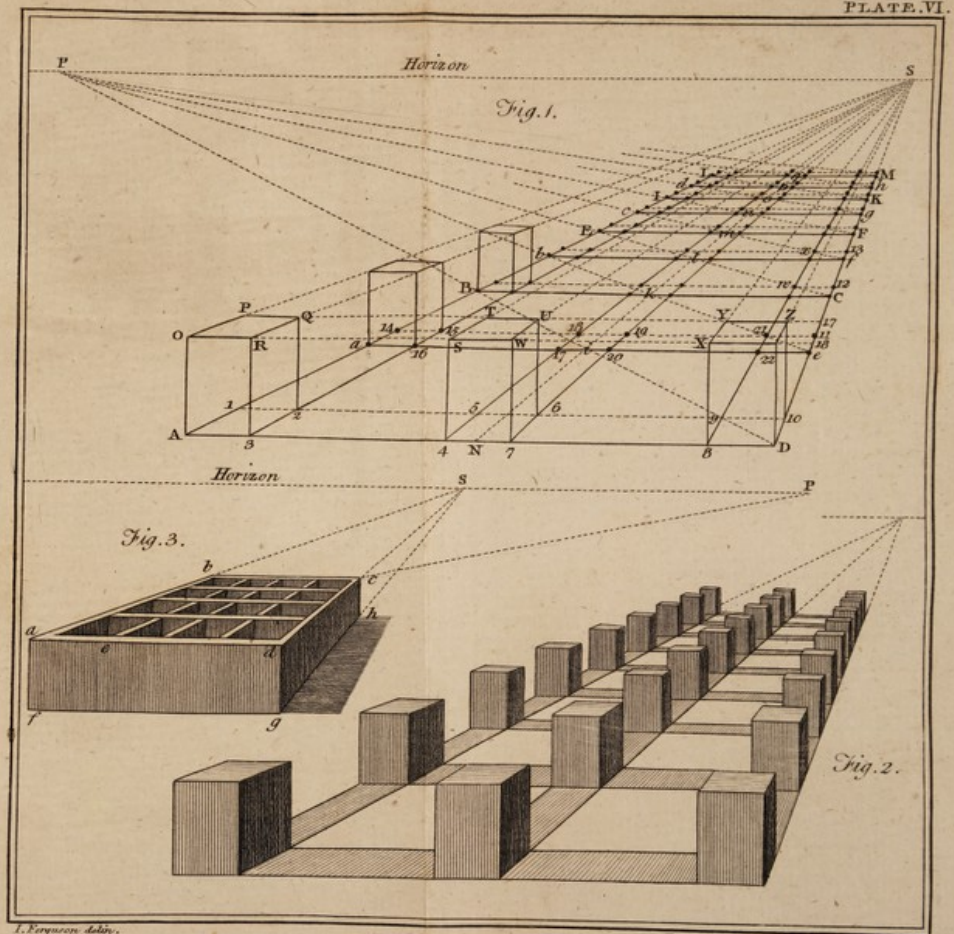




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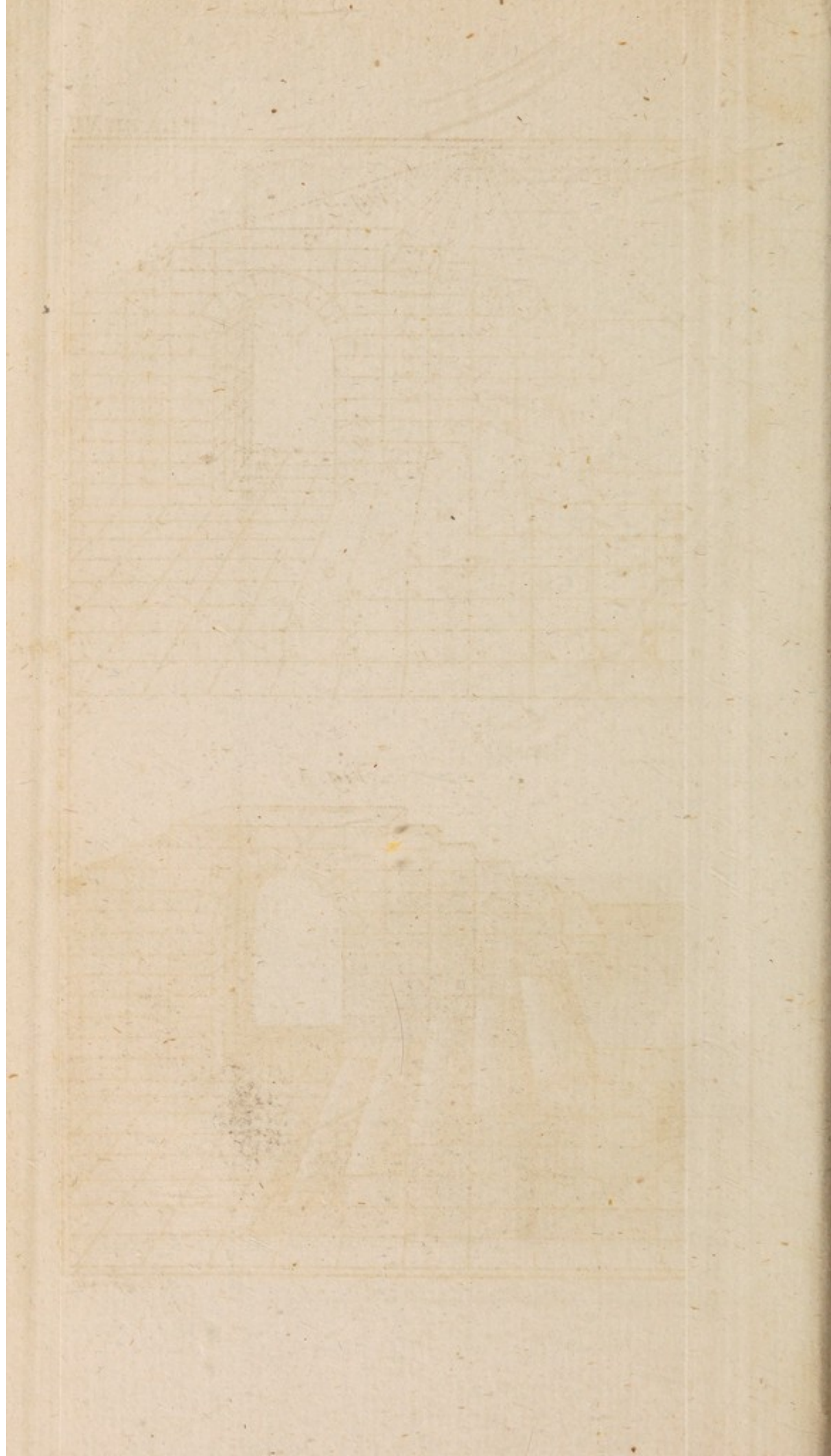
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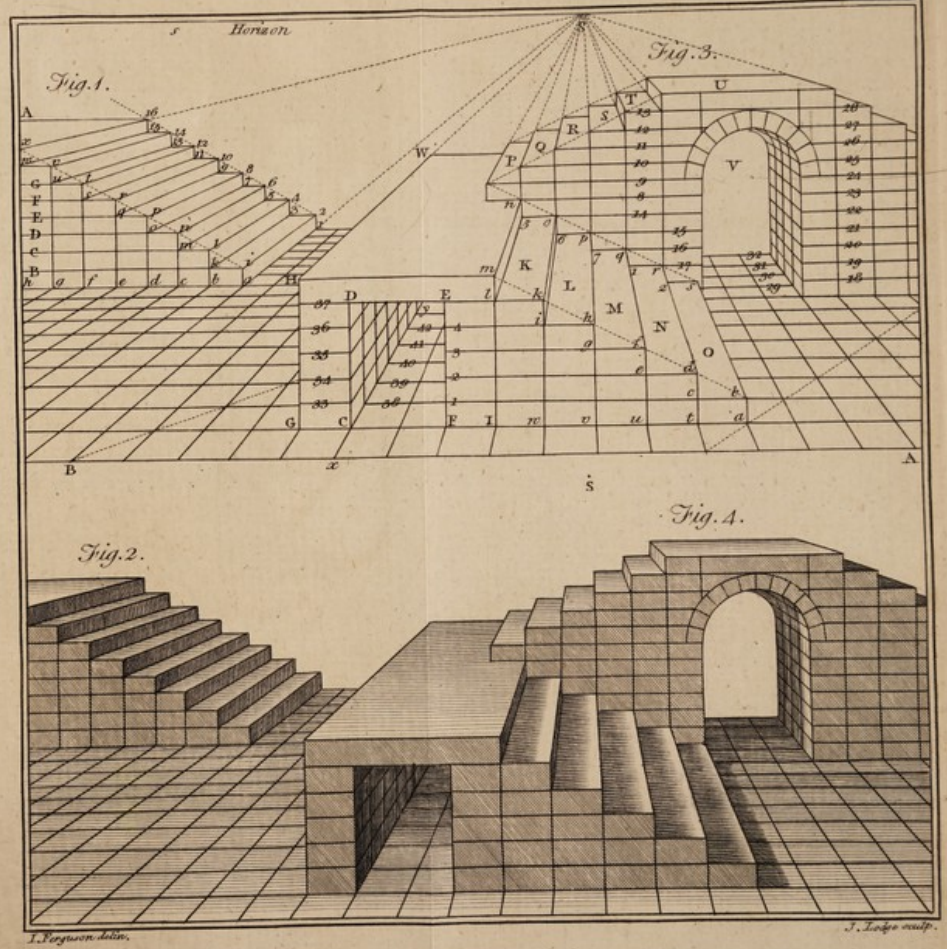




J. Ferguson delin.

J. Lodge sculp.







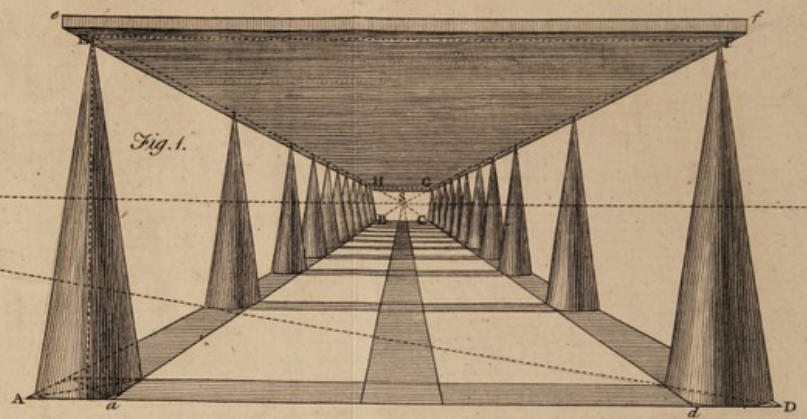


Fig. 1.

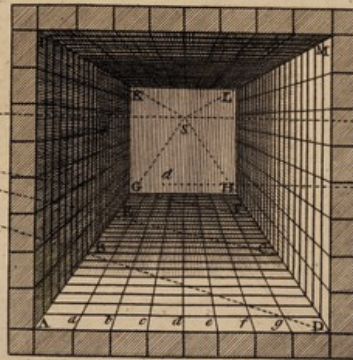


Fig. 3.

