

Euclid's Elements

Book III



A circle is a round straight line with a hole in the middle.

Mark Twain

quoting a schoolchild in "-English as She Is Taught-"

If people stand in a circle long enough, they'll eventually begin to dance.

George Carlin, Napalm and Silly Putty (2001)



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2	A chord of a circle always lies inside the circle	10	A circle does not cut a circle at more points than two	18	If line touches a circle, then it is perpendicular to the diameter that touches that point
3	A line through the centre of a circle bisects a chord, and vice versa	11	Point of contact between two internal circles, and their centres, are collinear	19	If line touches a circle, then the centre of the circle lies on a line perpendicular to the original
4	A line not through the centre of a circle does not bisect a chord	12	Point of contact between two external circles, and their centres, are collinear	20	The angle at the centre of a circle is twice that from an angle from the circumference
5	If two circles cut one another, they will not have the same center	13	A circle does not touch a circle at more points than one, whether it touch it internally or externally.	21	In a circle the angles in the same segment are equal to one another
6	If two circles touch one another, they will not have the same center	14	In a circle equal straight lines are equally distant from the centre, and those which are equally distant from the centre are equal to one another.	22	The opposite angles of quadrilaterals in circles are equal to two right angles
7	Consider two lines from a point inside a circle to the edge, the longer one will be the one closest to the longest part of the diameter passing through the original point	15	The longest line in a circle is its diameter, shorter the farther away from the diameter	23	On the same straight line there cannot be constructed two similar and unequal segments of circles on the same side
8	Consider two lines from a point outside a circle to the edge, the line closest to the centre will be longer on the concave side and shorter on the convex side	16	A line on the circle, perpendicular to the diameter, lies outside the circle	24	Similar segments of circles on equal straight lines are equal to one another



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| 26 | In equal circles equal angles stand on equal circumferences | 35 | If two circle chords intersect, the segments on one multiplied together equals the segments of the other multiplied together |
| 27 | In equal circles angles standing on equal circumferences are equal to one another | | |
| 28 | In equal circles equal straight lines cut off equal circumferences | 36 | Secant-tangent law |
| 29 | In equal circles equal circumferences are subtended by equal straight lines | 37 | Converse of the secant-tangent law |
| 30 | To bisect a given circumference | | |
| 31 | In a circle the angle in the semicircle is right ... | | |
| 32 | The angle between a tangent and a straight line cutting a circle is equal to the angle in the alternate segment | | |
| 33 | Construct a circle segment on a given line, such that the angle within the segment is equal to a given angle | | |



Proposition 17 of Book III

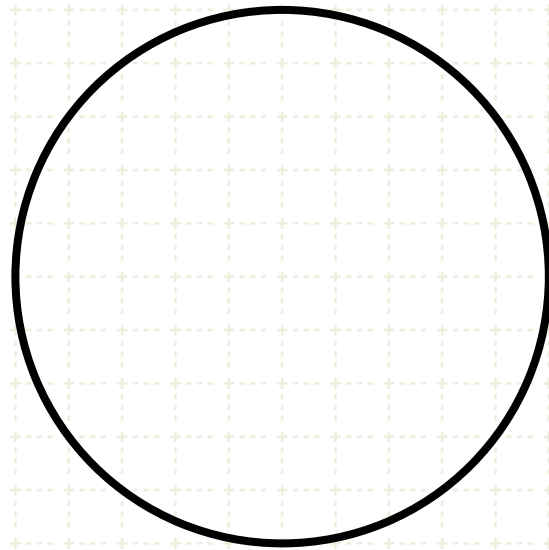
From a given point to draw a straight line touching a given circle.



Proposition 17 of Book III

From a given point to draw a straight line touching a given circle.

A
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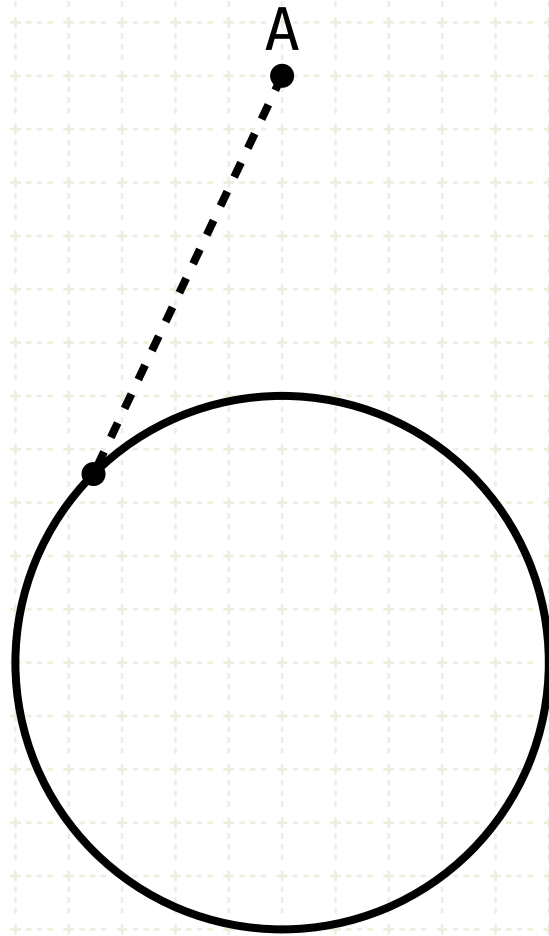
In other words

The methods required to draw a line from a given point such that it touches the given circle



Proposition 17 of Book III

From a given point to draw a straight line touching a given circle.



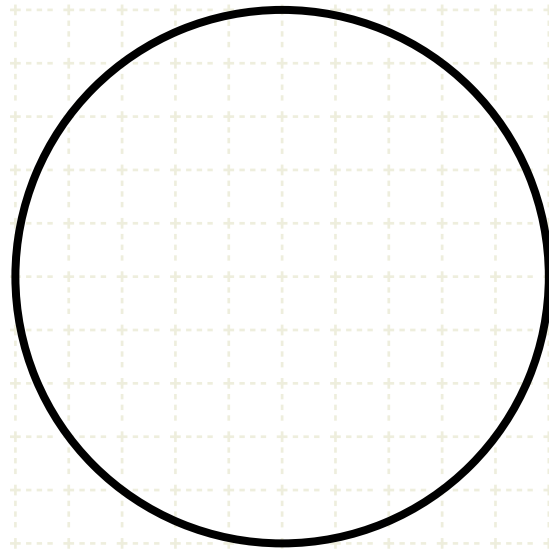
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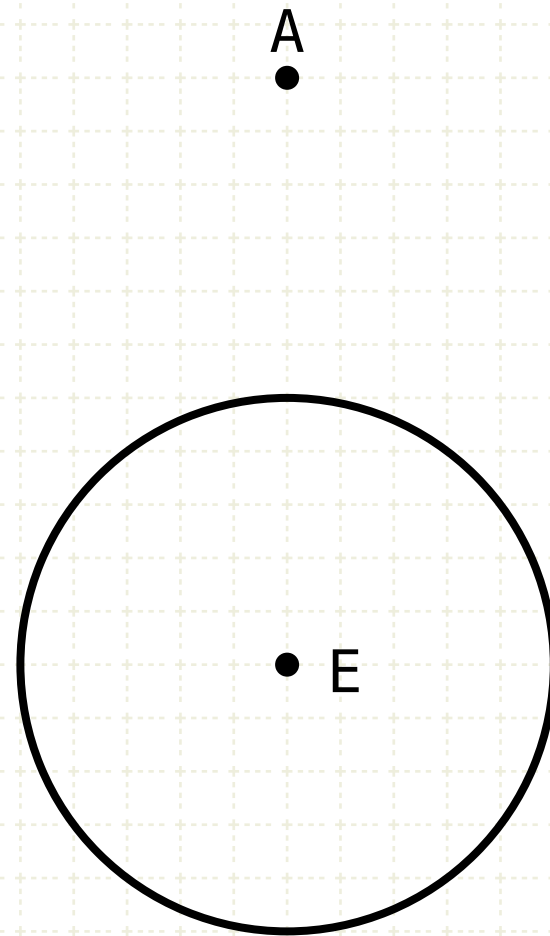


Construction



Proposition 17 of Book III

From a given point to draw a straight line touching a given circle.

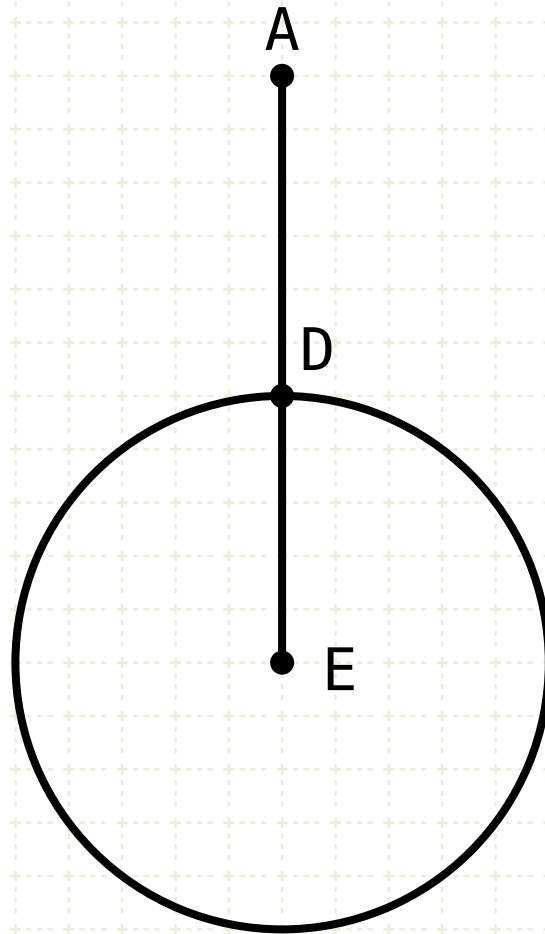


Construction

Find the centre of the circle E (III·1)

Proposition 17 of Book III

From a given point to draw a straight line touching a given circle.



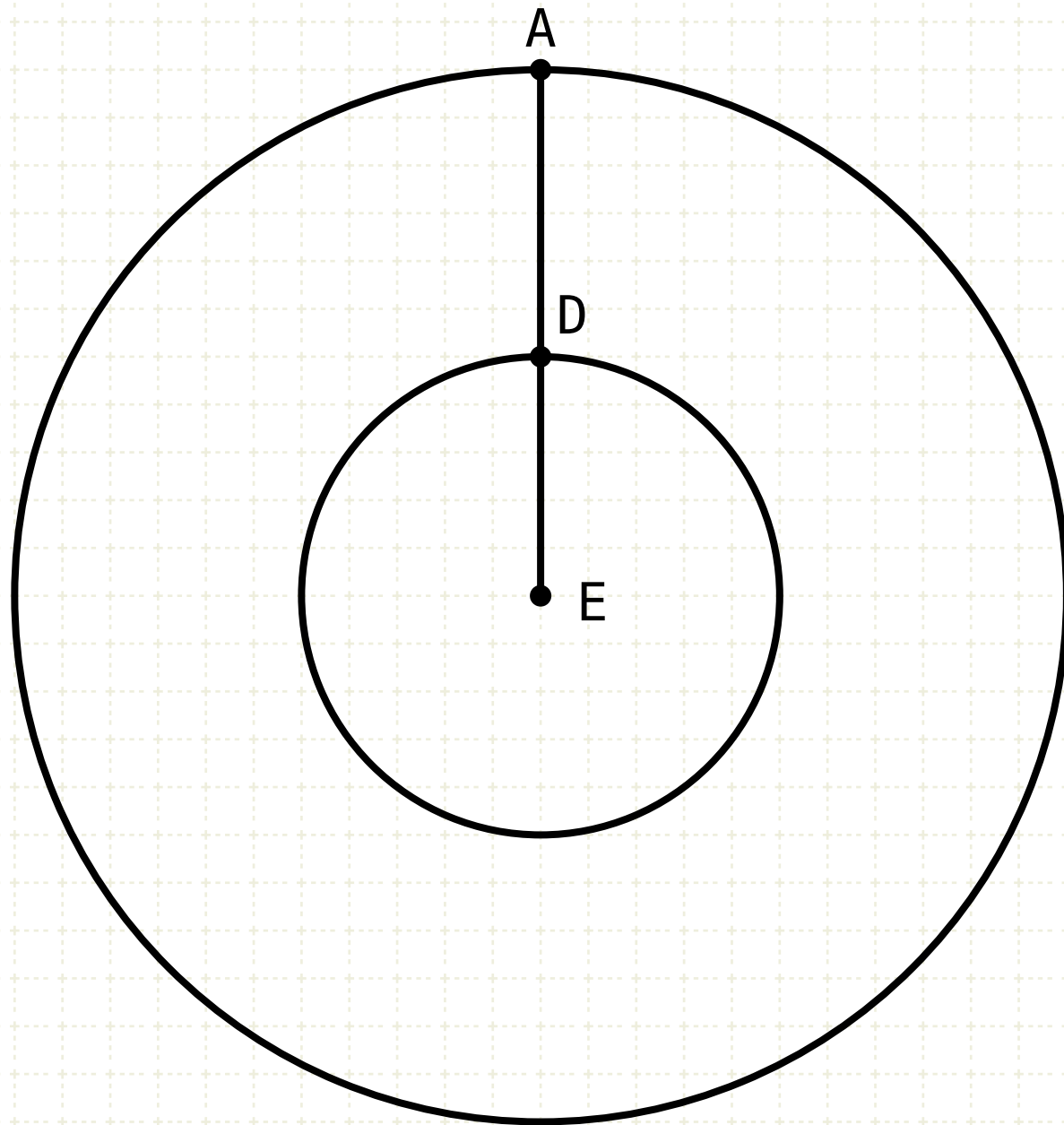
Construction

Find the centre of the circle E (III·1)

Draw the line AE

Proposition 17 of Book III

From a given point to draw a straight line touching a given circle.



Construction

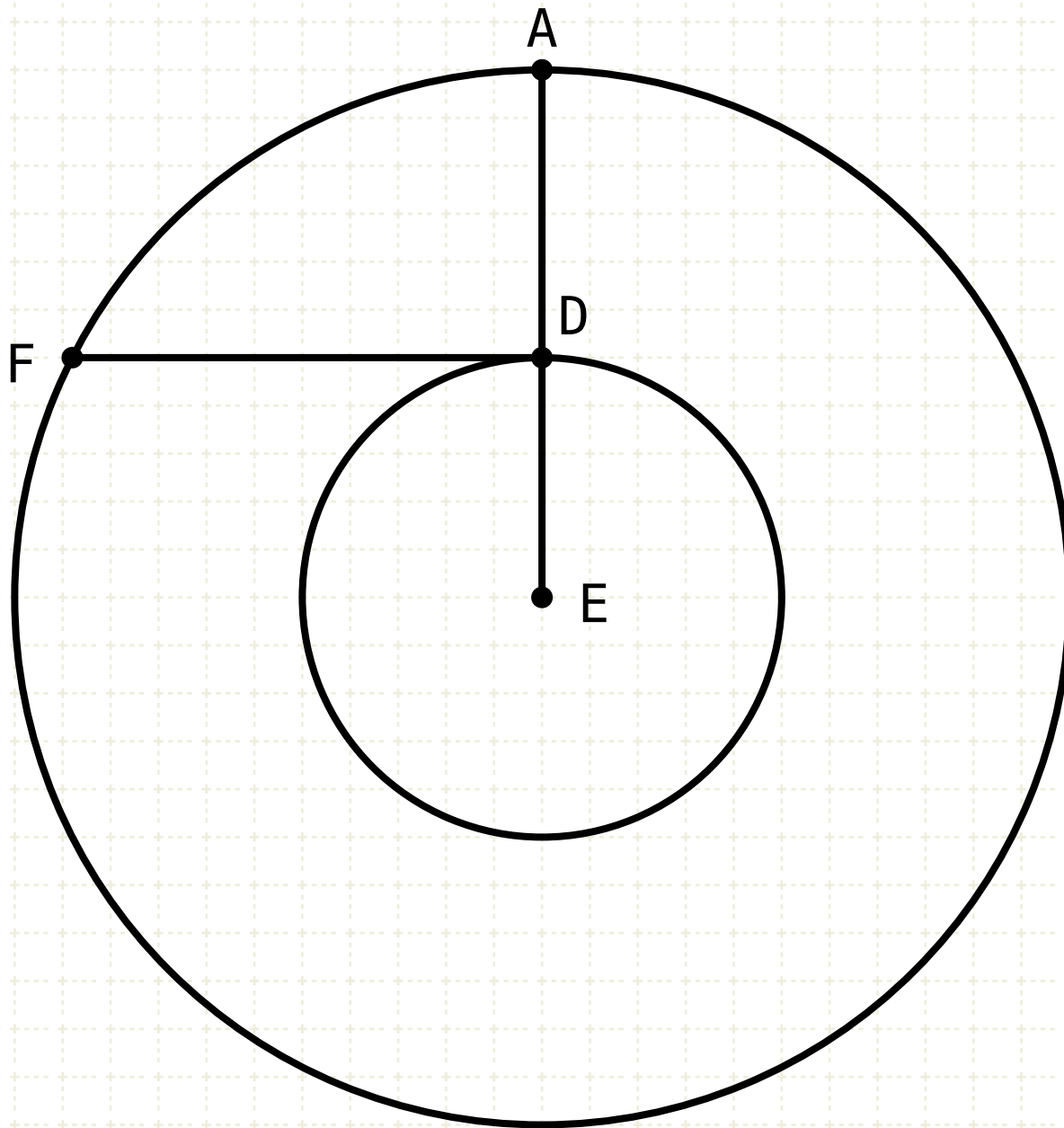
Find the centre of the circle E (III·1)

Draw the line AE

Construct a circle with the centre at E, and radius AE

Proposition 17 of Book III

From a given point to draw a straight line touching a given circle.



$$\angle FDE = L$$

Construction

Find the centre of the circle E (III·1)

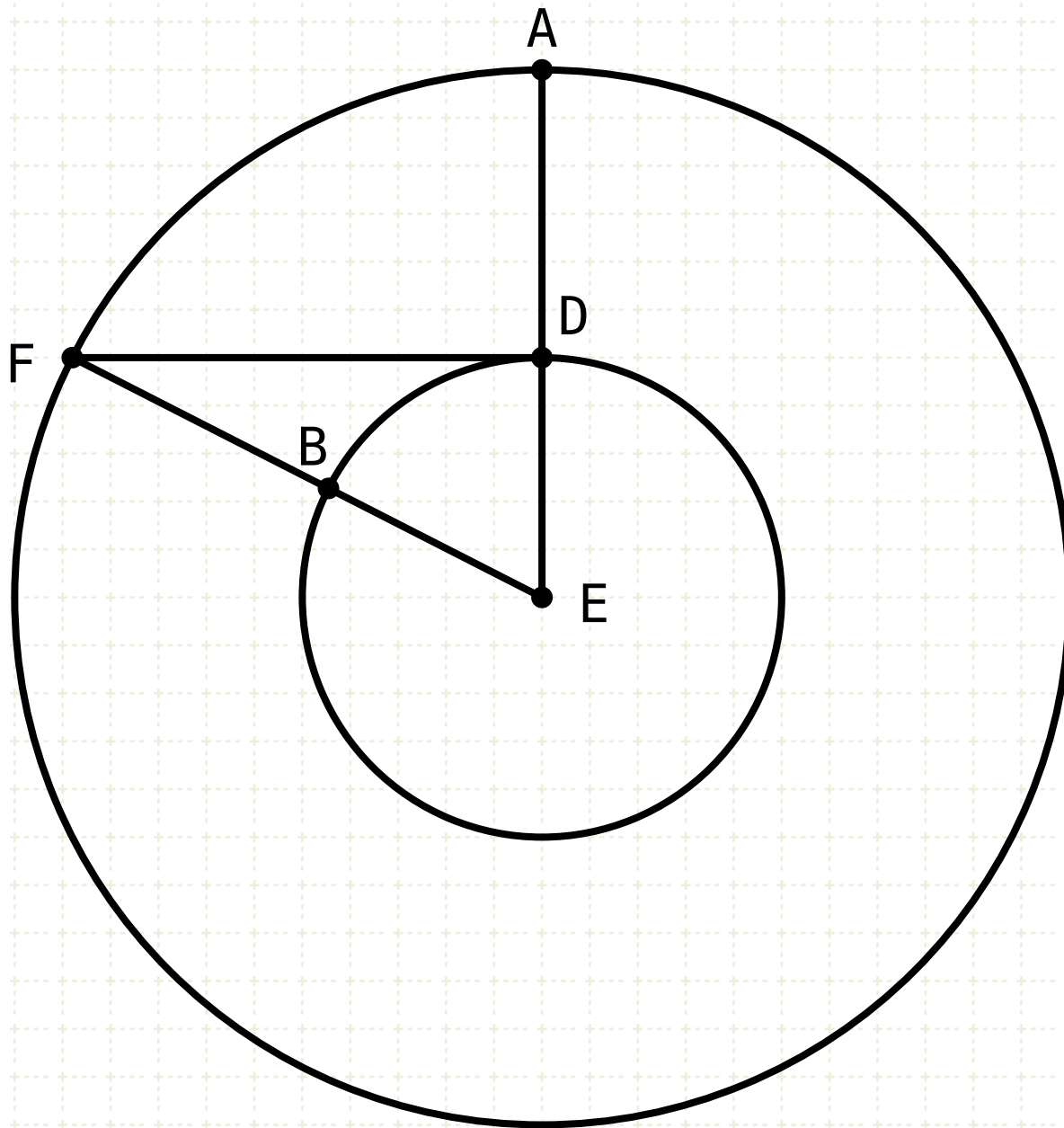
Draw the line AE

Construct a circle with the centre at E, and radius AE

Construct a line perpendicular to AE from point D, intersecting the larger circle at F

Proposition 17 of Book III

From a given point to draw a straight line touching a given circle.



$$\angle FDE = L$$

Construction

Find the centre of the circle E (III·1)

Draw the line AE

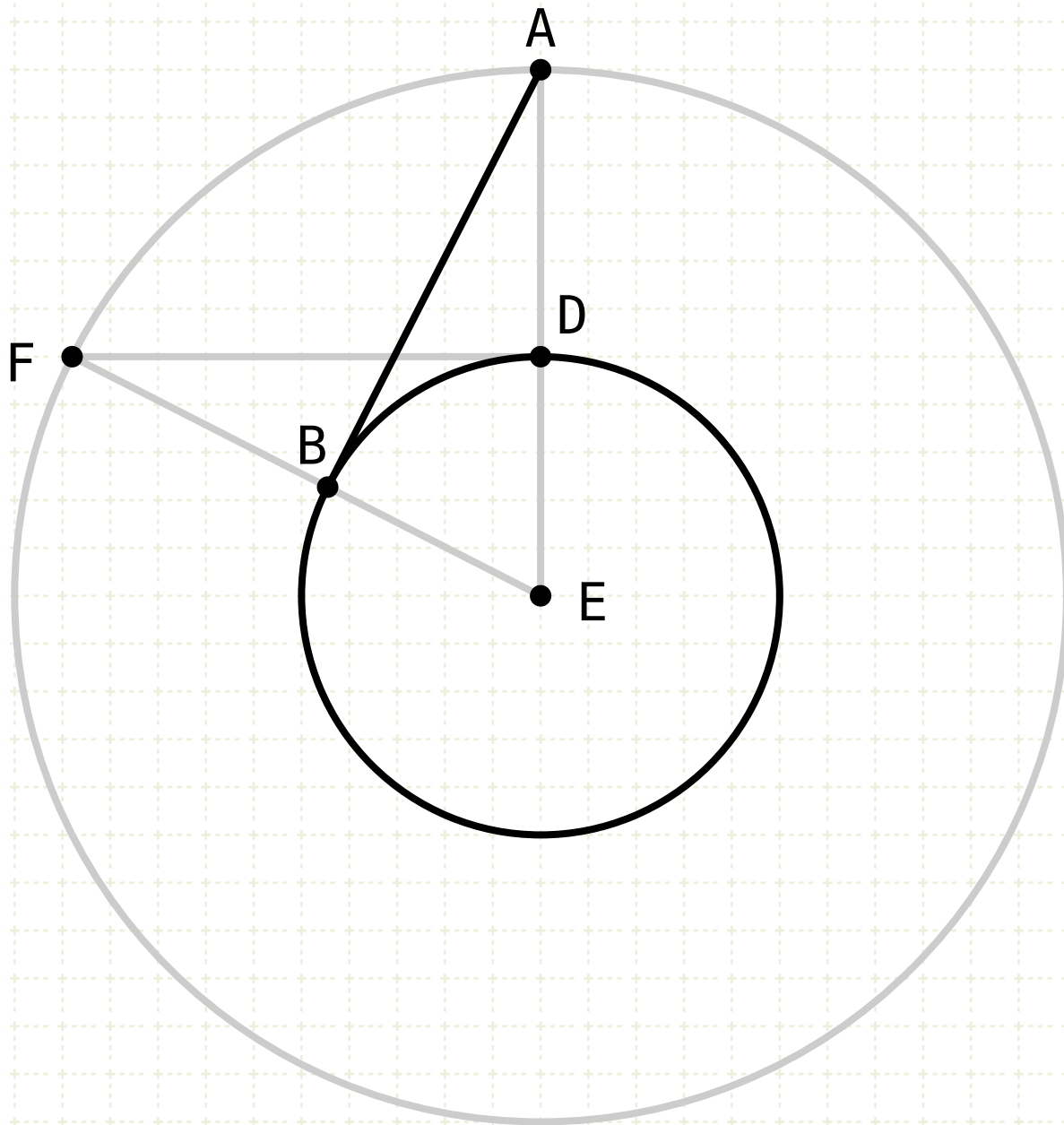
Construct a circle with the centre at E, and radius AE

Construct a line perpendicular to AE from point D, intersecting the larger circle at F

Draw line FE, intersecting the smaller circle at point B

Proposition 17 of Book III

From a given point to draw a straight line touching a given circle.



$$\angle FDE = \angle L$$

Construction

Find the centre of the circle E (III·1)

Draw the line AE

Construct a circle with the centre at E, and radius AE

Construct a line perpendicular to AE from point D, intersecting the larger circle at F

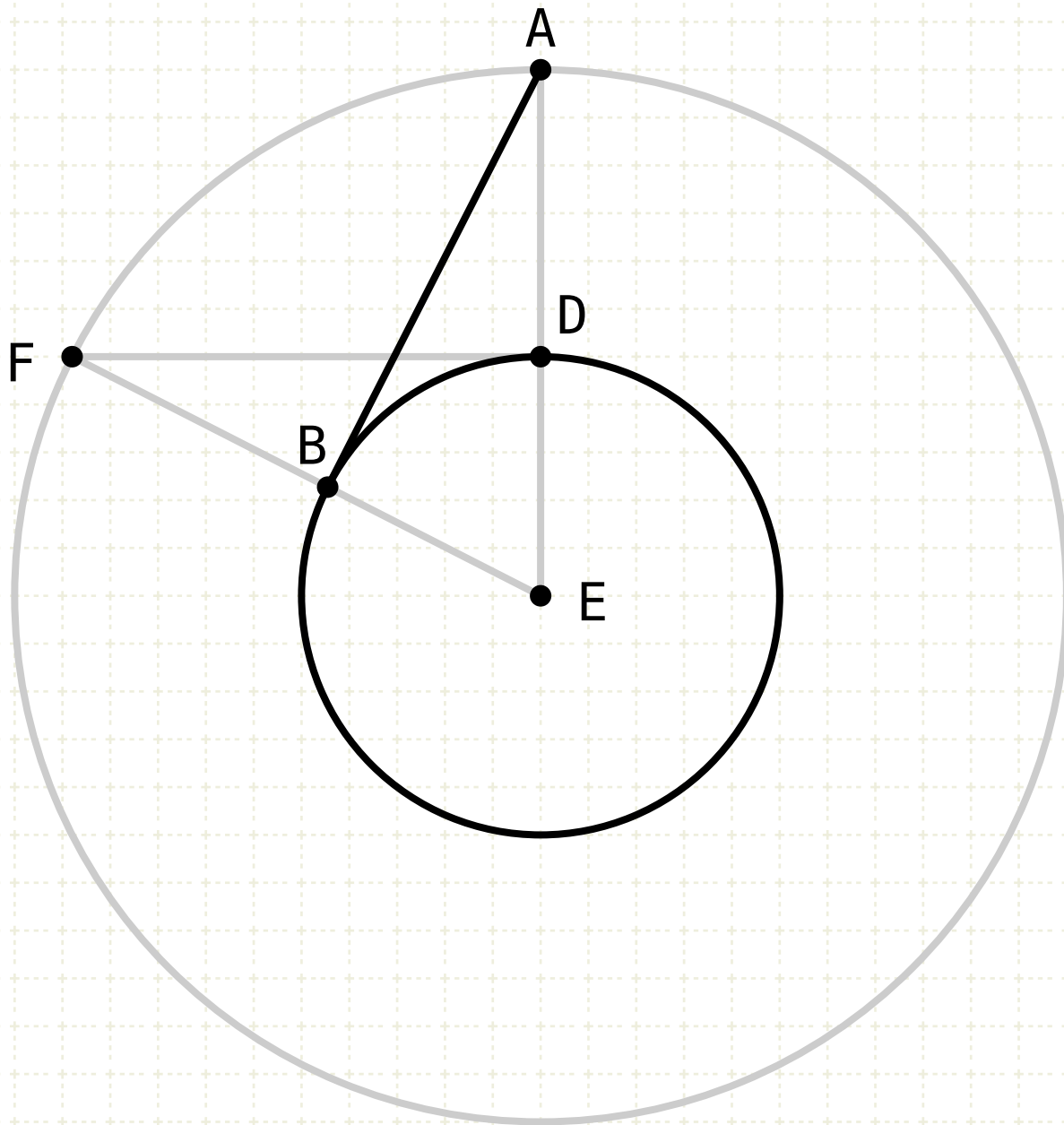
Draw line FE, intersecting the smaller circle at point B

Draw line AB, which touches the circle at B



Proposition 17 of Book III

From a given point to draw a straight line touching a given circle.



$$\angle FDE = L$$

Construction

Find the centre of the circle E (III·1)

Draw the line AE

Construct a circle with the centre at E, and radius AE

Construct a line perpendicular to AE from point D, intersecting the larger circle at F

Draw line FE, intersecting the smaller circle at point B

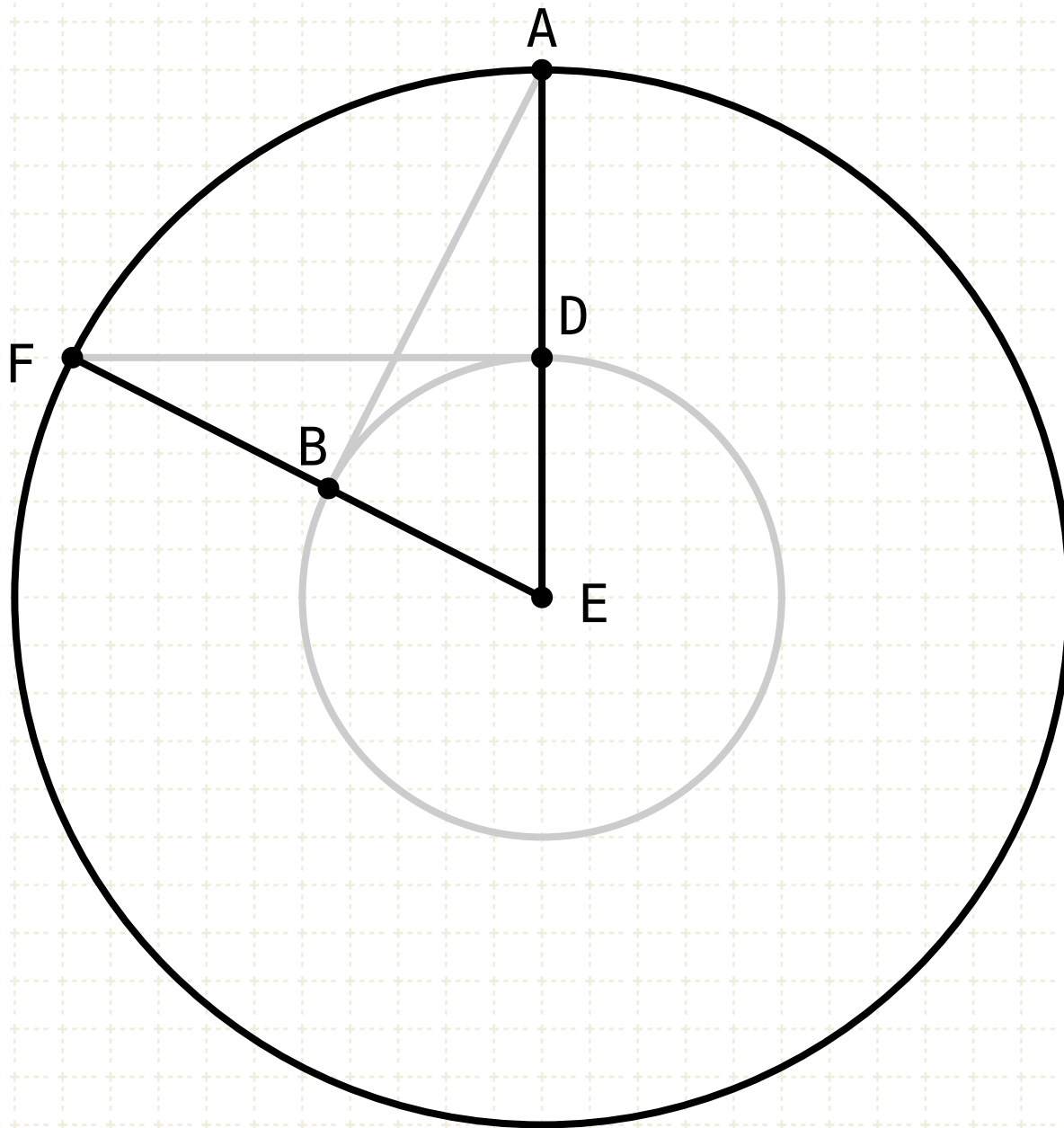
Draw line AB, which touches the circle at B

Proof



Proposition 17 of Book III

From a given point to draw a straight line touching a given circle.



$$\angle FDE = \angle A$$
$$AE = FE$$

Construction

Find the centre of the circle E (III·1)

Draw the line AE

Construct a circle with the centre at E, and radius AE

Construct a line perpendicular to AE from point D, intersecting the larger circle at F

Draw line FE, intersecting the smaller circle at point B

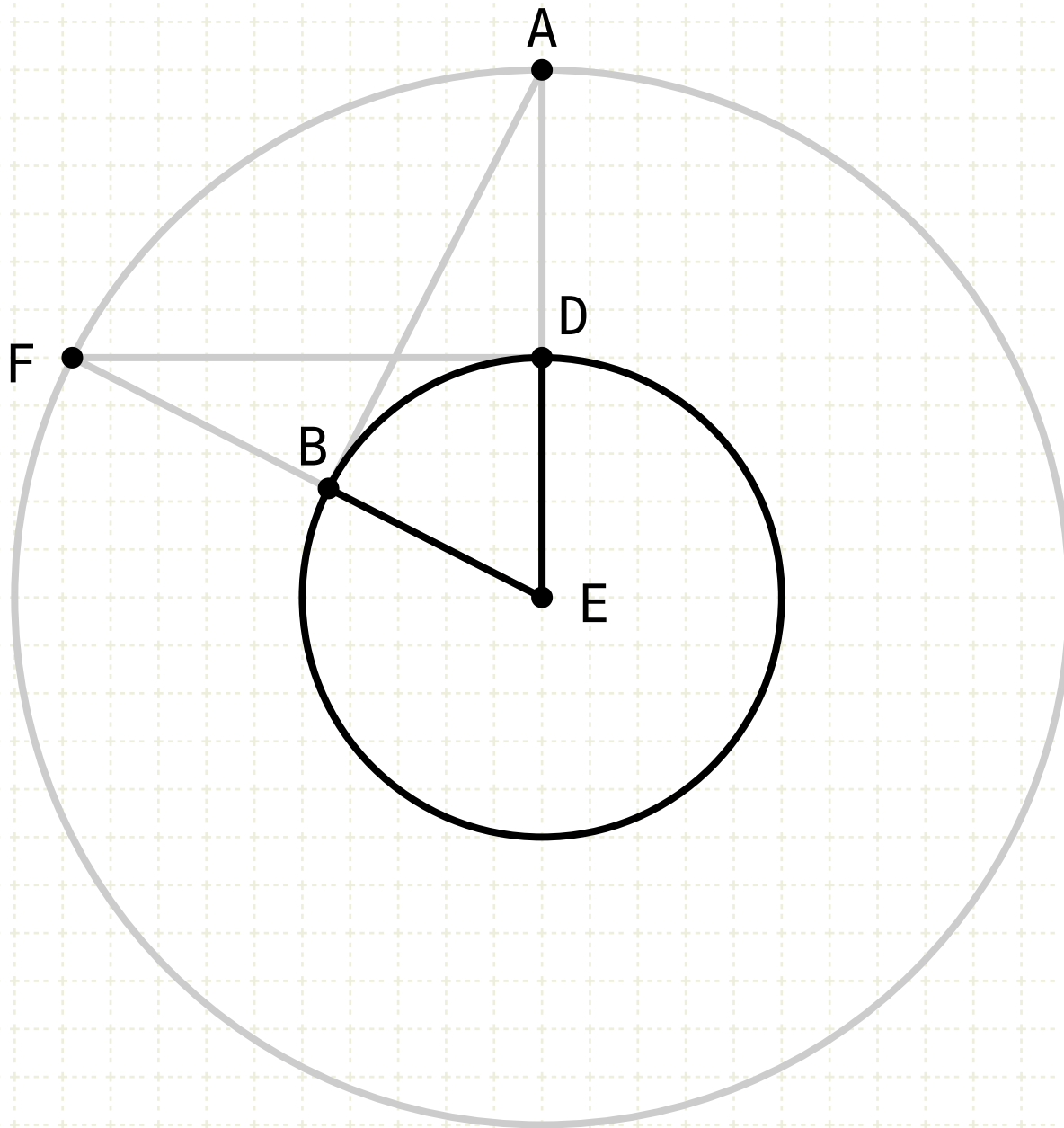
Draw line AB, which touches the circle at B

Proof

Lines AE,FE are equal, as are DE and BE

Proposition 17 of Book III

From a given point to draw a straight line touching a given circle.



$$\angle FDE = \angle ADE$$

$$AE = FE$$

$$DE = BE$$

Construction

Find the centre of the circle E (III·1)

Draw the line AE

Construct a circle with the centre at E, and radius AE

Construct a line perpendicular to AE from point D, intersecting the larger circle at F

Draw line FE, intersecting the smaller circle at point B

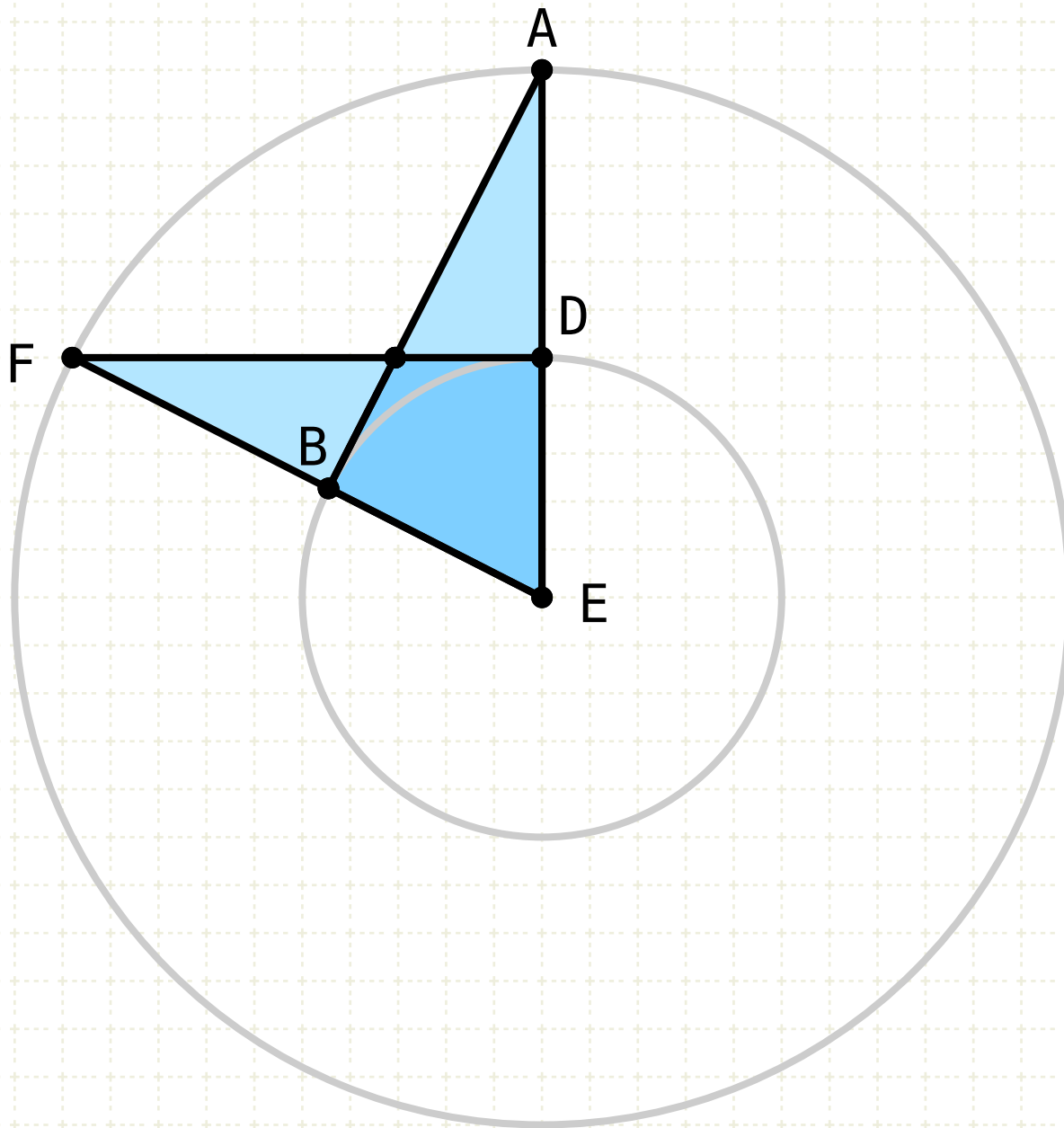
Draw line AB, which touches the circle at B

Proof

Lines AE,FE are equal, as are DE and BE

Proposition 17 of Book III

From a given point to draw a straight line touching a given circle.



$$\angle FDE = \angle A$$

$$AE = FE$$

$$DE = BE$$

$$\triangle ABE \cong \triangle FDE$$

Construction

Find the centre of the circle E (III·1)

Draw the line AE

Construct a circle with the centre at E, and radius AE

Construct a line perpendicular to AE from point A, intersecting the larger circle at F

Draw line FE, intersecting the smaller circle at point B

Draw line AB, which touches the circle at B

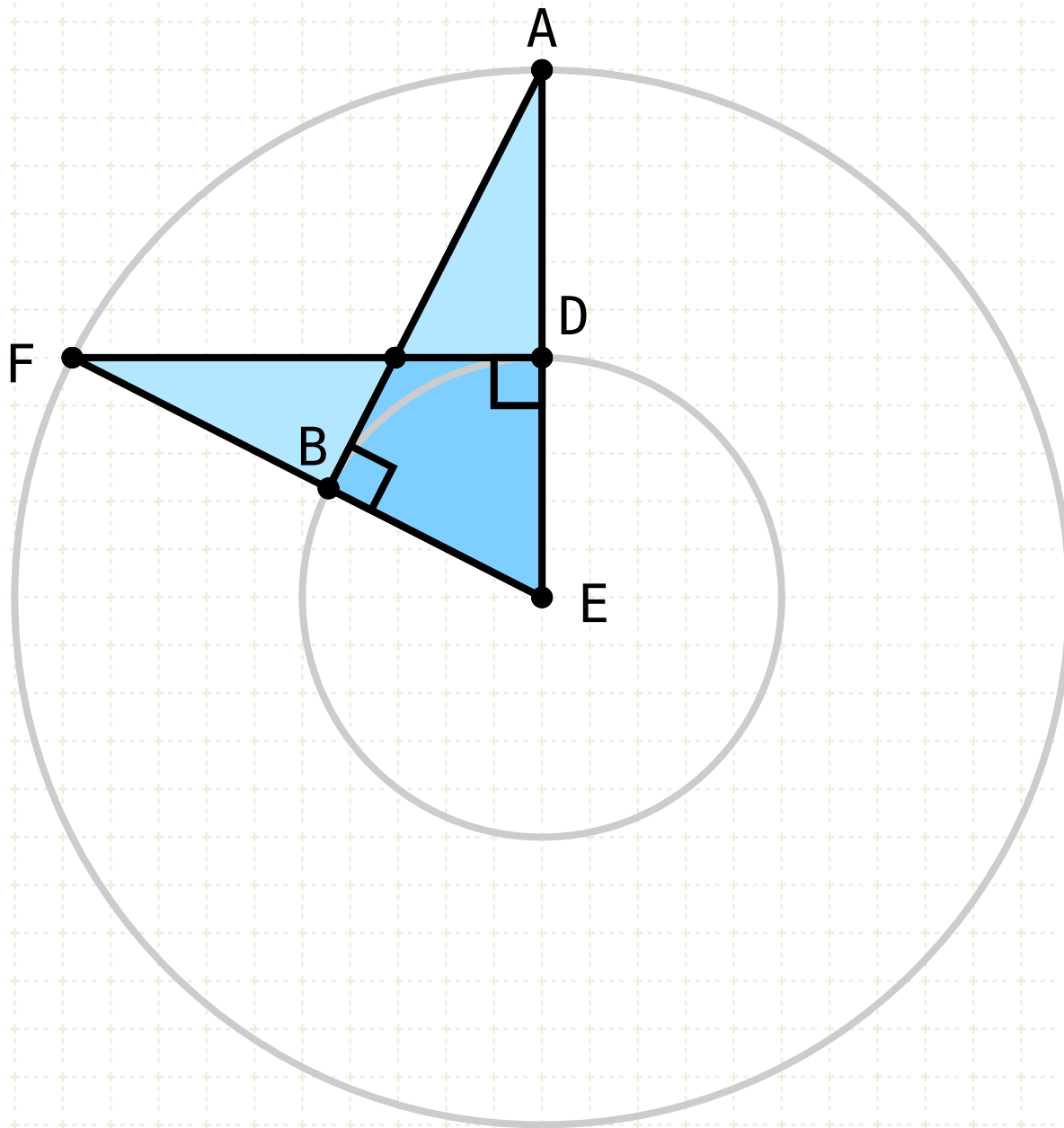
Proof

Lines AE, FE are equal, as are DE and BE

Two triangles with two sides equal to two sides and a common angle at E, are equivalent (I·4) (SAS)

Proposition 17 of Book III

From a given point to draw a straight line touching a given circle.



$$\angle FDE = \angle L$$

$$AE = FE$$

$$DE = BE$$

$$\triangle ABE \equiv \triangle FDE$$

$$\angle FDE = \angle ABE$$

$$\therefore \angle ABE = \angle L$$

Construction

Find the centre of the circle E (III·1)

Draw the line AE

Construct a circle with the centre at E, and radius AE

Construct a line perpendicular to AE from point D, intersecting the larger circle at F

Draw line FE, intersecting the smaller circle at point B

Draw line AB, which touches the circle at B

Proof

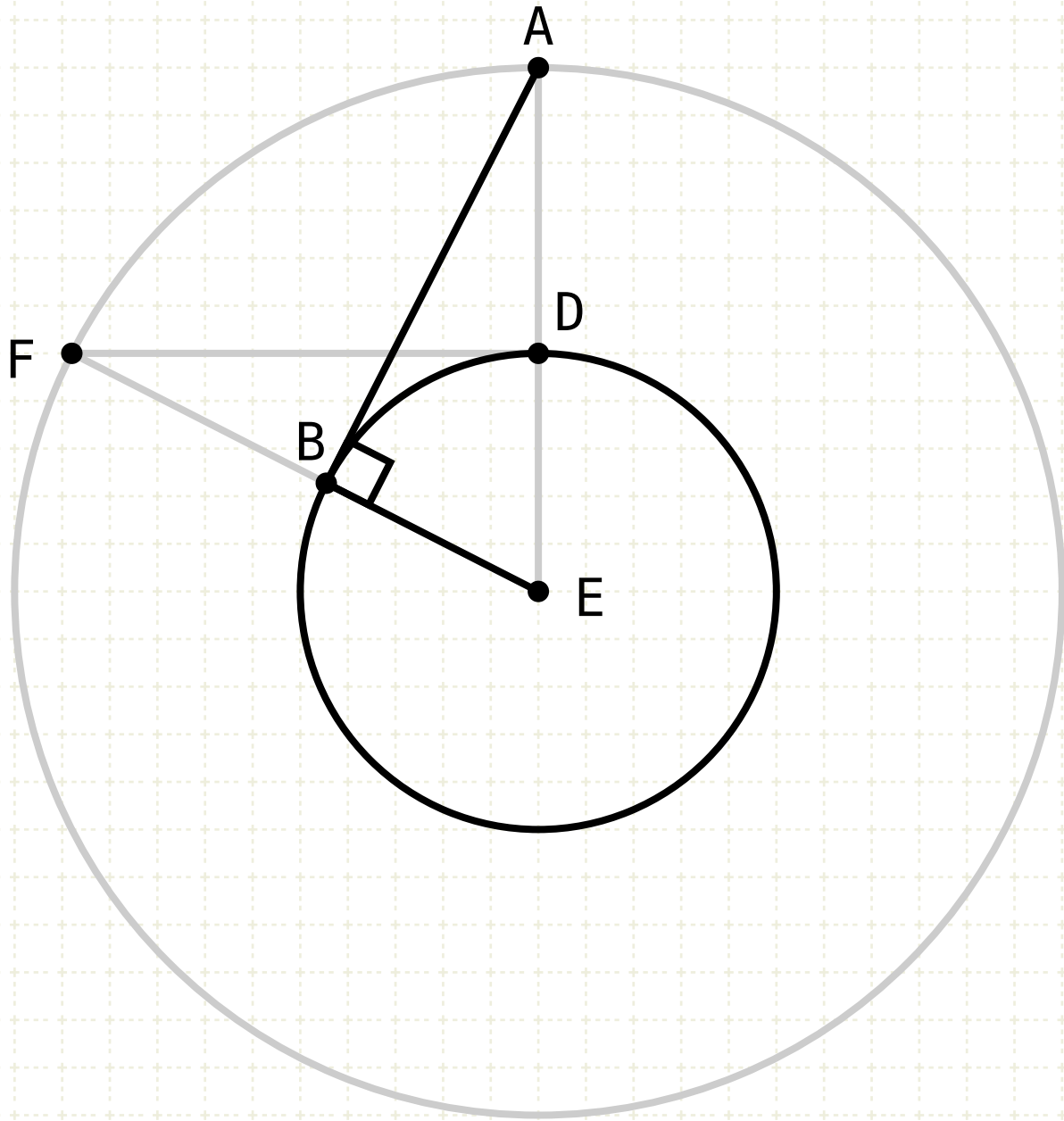
Lines AE, FE are equal, as are DE and BE

Two triangles with two sides equal to two sides and a common angle at E, are equivalent (I·4) (SAS)

So angle ABE is equal to FDE, which is a right angle by construction, therefore ABE is right

Proposition 17 of Book III

From a given point to draw a straight line touching a given circle.



$$\angle FDE = \angle L$$

$$AE = FE$$

$$DE = BE$$

$$\triangle ABE \cong \triangle FDE$$

$$\angle FDE = \angle ABE$$

$$\therefore \angle ABE = \angle L$$

$$EB \perp AB$$

Construction

Find the centre of the circle E (III·1)

Draw the line AE

Construct a circle with the centre at E, and radius AE

Construct a line perpendicular to AE from point D, intersecting the larger circle at F

Draw line FE, intersecting the smaller circle at point B

Draw line AB, which touches the circle at B

Proof

Lines AE,FE are equal, as are DE and BE

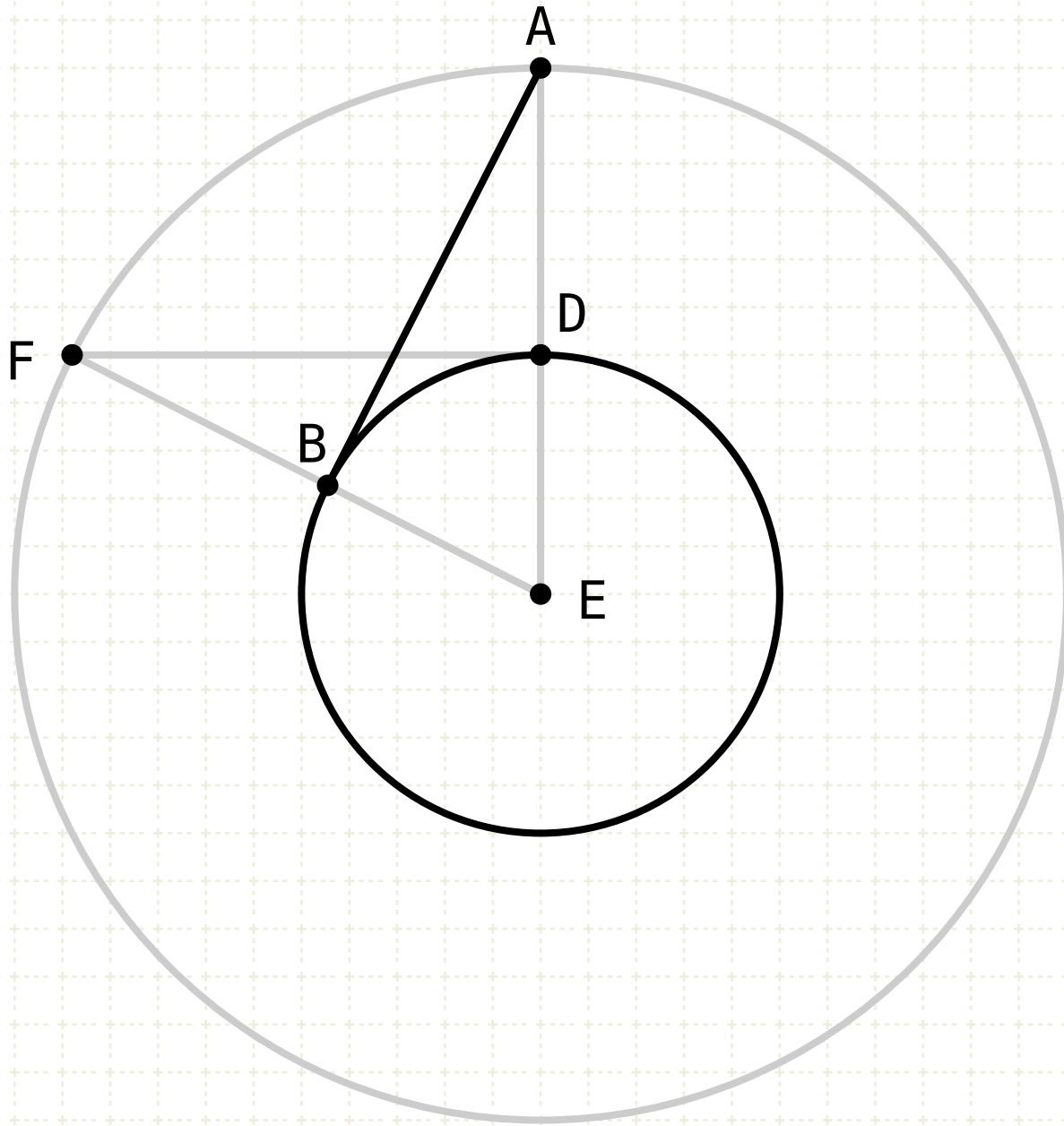
Two triangles with two sides equal to two sides and a common angle at E, are equivalent (I·4) (SAS)

So angle ABE is equal to FDE, which is a right angle by construction, therefore ABE is right

EB is the radius, and a line drawn at perpendicular to the diameter of a circle (at the extremities), touches the circle (III·16)

Proposition 17 of Book III

From a given point to draw a straight line touching a given circle.



$$\angle FDE = L$$

$$AE = FE$$

$$DE = BE$$

$$\Delta ABE \equiv \Delta FDE$$

$$\angle FDE = \angle ABE$$

$$\therefore \angle ABE = L$$

$$EB \perp AB$$

Construction

Find the centre of the circle E (III-1)

Draw the line AE

Construct a circle with the centre at E, and radius AE

Construct a line perpendicular to AE from point D, intersecting the larger circle at F

Draw line FE, intersecting the smaller circle at point B

Draw line AB, which touches the circle at B

Proof

Lines AE,FE are equal, as are DE and BE

Two triangles with two sides equal to two sides and a common angle at E, are equivalent (I.4) (SAS)

So angle ABE is equal to FDE, which is a right angle by construction, therefore ABE is right

EB is the radius, and a line drawn at perpendicular to the diameter of a circle (at the extremities), touches the circle (III·16)

Therefore, the line AB touches the circle at B



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