
HEUER
CALCULATOR
AUTOMATIC
CHRONOGRAPH
SWISS
km
kg l
yd
mph
kt naut
in
ft
US gal
I gal. lb

Description of the scales of the Heuer Calculator

The calculating-circles of the Heuer Calculator consist of a fixed inner scale and a rotating outer ring. The beginning and the end of the fixed scale, which are indicated by the mark ▲, are always at the top, close to the numeral 12. The scale on the outer ring begins and ends at the mark ▼. Each of the two marks may represent both 1 and 10. When a calculation is made, their meaning is perfectly clear according to the following rule:
The given numbers and those which are sought are observed on each ring in clockwise (or counter-clockwise) succession. The marks ▲ and ▼ represent 1 (or 10) at the beginning of the observation; the following values correspond to the numbers indicated, provided that no mark is passed over in the course of the observation. When a mark is passed over, it represents 10 (or 1), and the following values on the ring concerned are 10 times greater (or smaller) than the numbers indicated.
The two scales are graduated logarithmically; the divisions are therefore unevenly spaced. Between 1 and 2, the spaces between two divisions represent 0.02 units; between 2 and 5, they represent 0.05 units already and between 5 and 10, 0.1 units. The smallest spaces are about half a millimetre wide, and the largest amount to slightly more than one millimetre. Those who have good eyesight can estimate intermediate values; in the examples, estimated intermediate values are indicated by smaller figures. For instance, 5.2$_5$ is exactly midway between the divisions 5.2 and 5.3; 3.8$_2$ is slightly closer to the division 3.8 than to the division 3.85.

Accuracy

If one takes the trouble to estimate tenths of a millimetre correctly, one can obtain a degree of accuracy of $2\,^0/_{00}$ with the calculating-scales of the Heuer Calculator; if one is content with half millimetres, the degree of accuracy is 1%.

Use of the calculating-scales

Multiplication $a \times b = p$

Principle

Find the first factor a on the outer ring and turn the ring until the number a is above the mark ▲. Find the second factor on the inner scale and read off the result p at the same place on the outer ring.

Generally speaking, a calculator estimates the position value of the result in his head. However the position value can be clearly determined according to the following rule:
Reading **clockwise** from the mark ▲, find the number b on the inner ring; if the mark ▼ on the outer ring has not been passed over, the result is equal to the number which is read off (cf. diagram A), otherwise the result is 10 times greater (cf. diagram B).

Diagram A

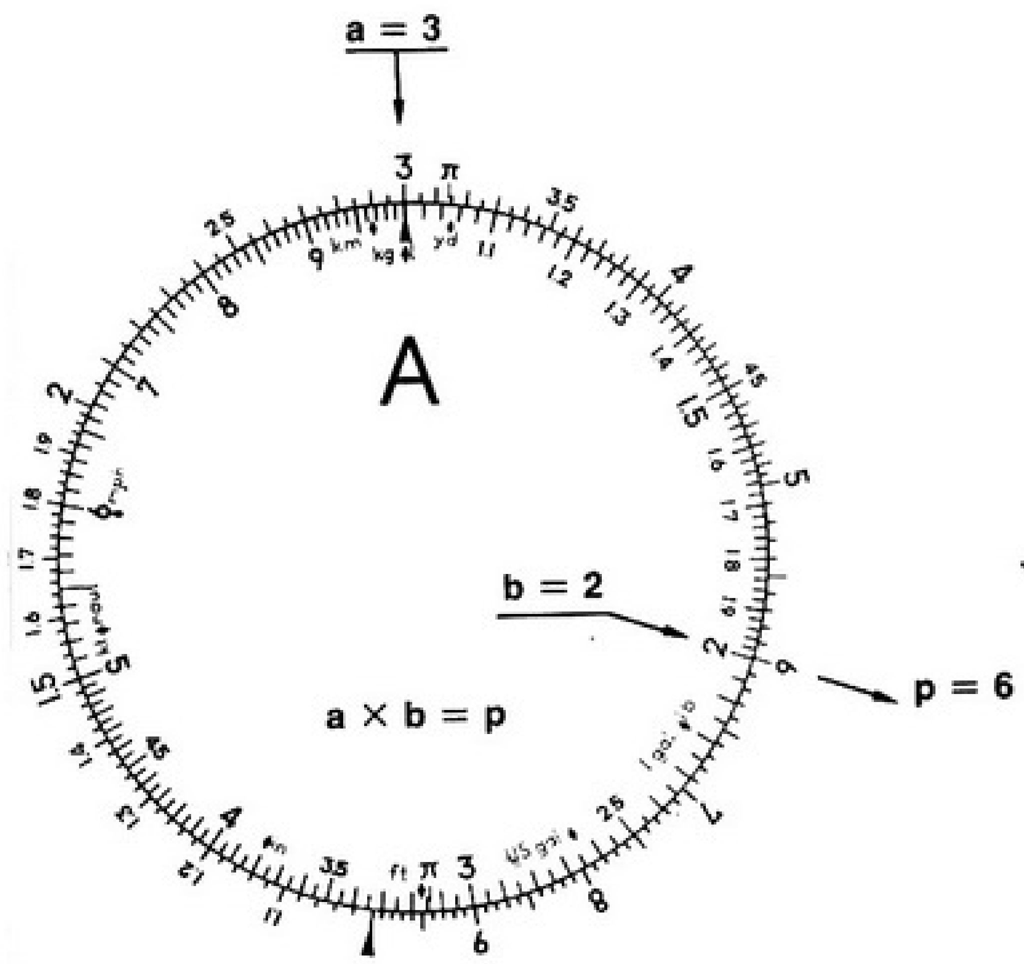
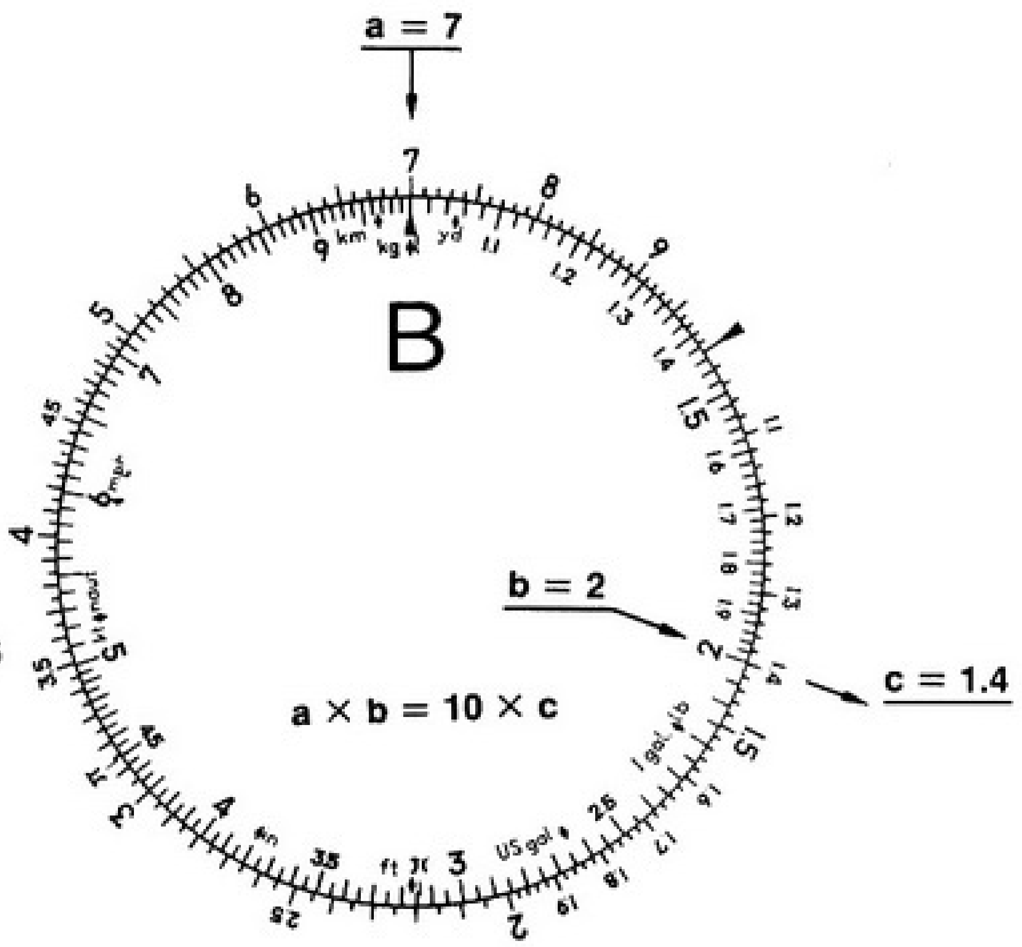


Diagram B



Division $\frac{p}{d} = q$

Principle

Find the number p (dividend) on the outer ring and turn the ring until the number d (divisor) on the inner scale is opposite to p.
The result of the division, q (quotient), can be read off at the top of the outer ring, opposite to the mark ▲. The position value of the result can be estimated or systematically determined as follows:
After having turned the ring, follow the outer scale **counter-clockwise**, from the dividend as far as 12, if the mark ▼ has not been passed over, the result coincides with the number that is read off (cf. diagram C), otherwise the result amounts to one tenth of the value indicated (cf. diagram D).

Diagram C

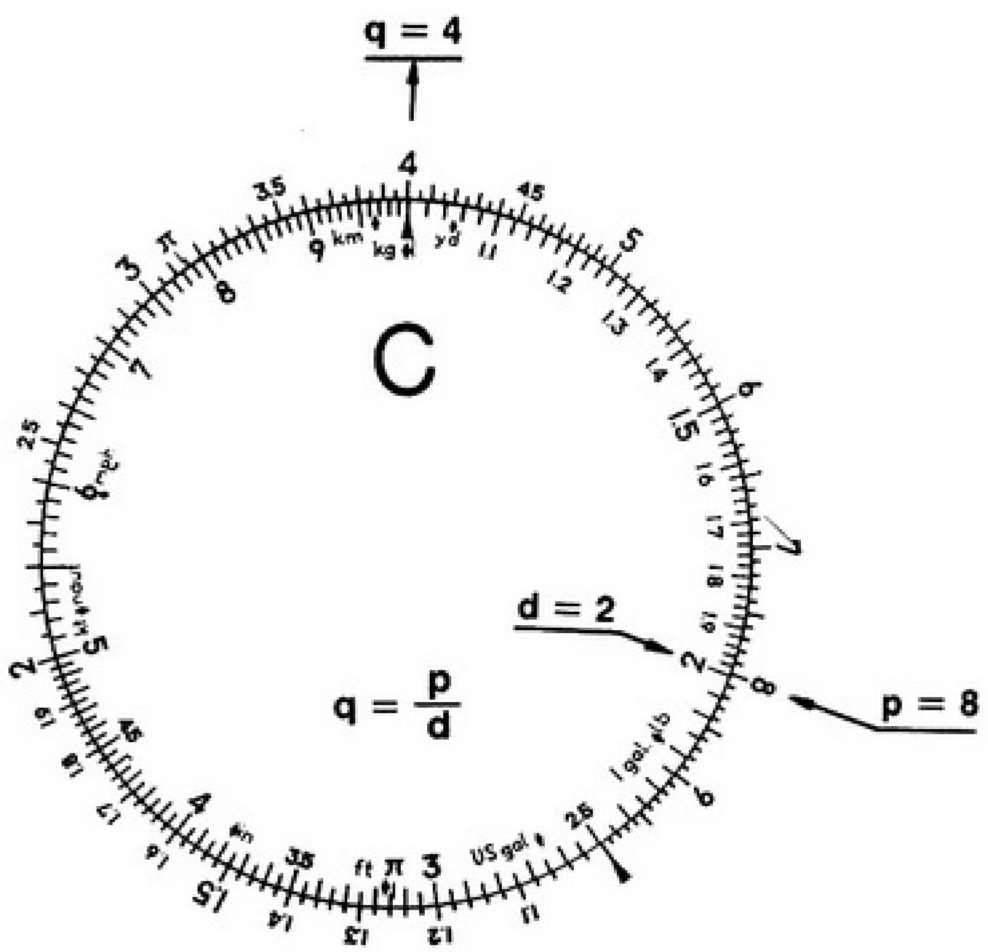
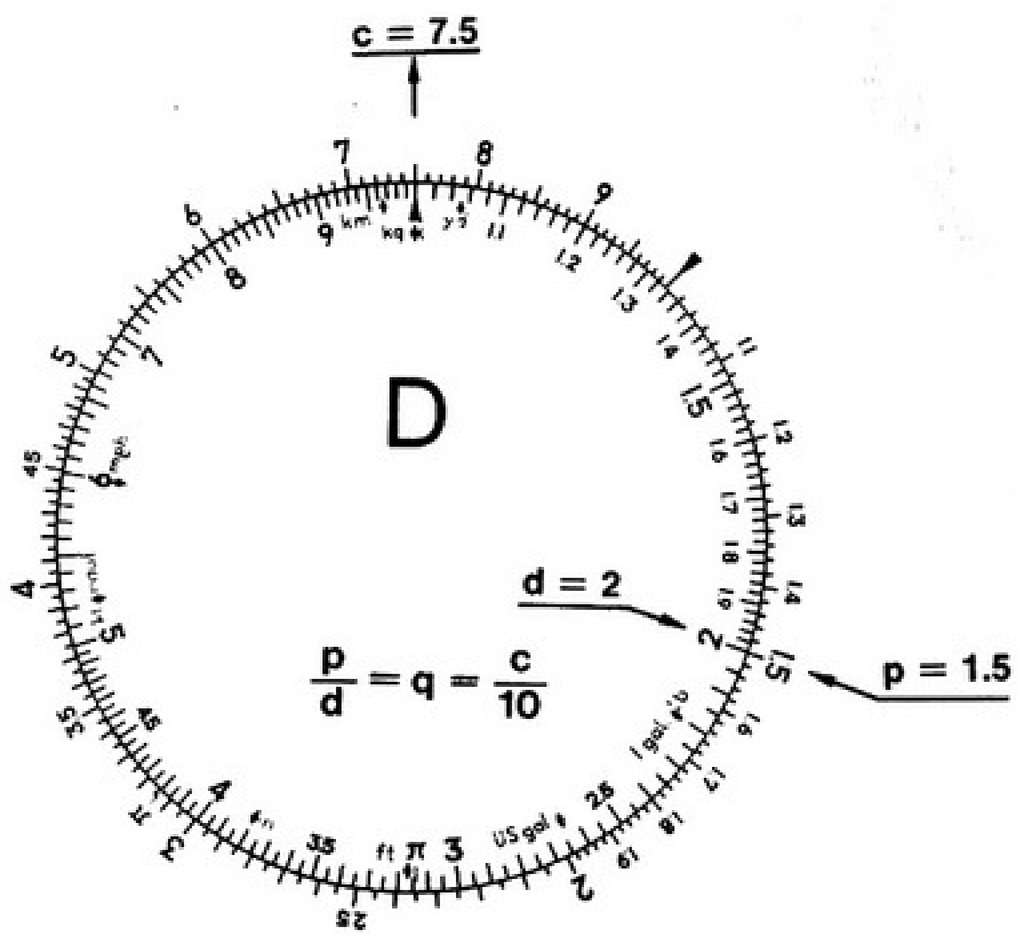


Diagram D



Proportions or simple rule of three

The proportion $\frac{a}{b} = \frac{x}{c}$ is equivalent to the rule of three $x = \frac{ac}{b}$

Principle

First find the quotient $\frac{a}{b}$ and multiply it by the third of the given values.

Procedure

Find the number a on the outer ring, then turn the ring until a is opposite to the number b on the inner scale. Find the number c on the inner scale; the result will be indicated on the outer ring, opposite to c.
The position value of the result can be determined in this case as follows: if, looking clockwise, the marks ▲ and ▼ are found not more than once between the first position a/b and the second position x/c on the outer and inner rings, the value x which is sought can be directly read off, as it corresponds to the number shown (cf. diagram E or F).

Diagram E

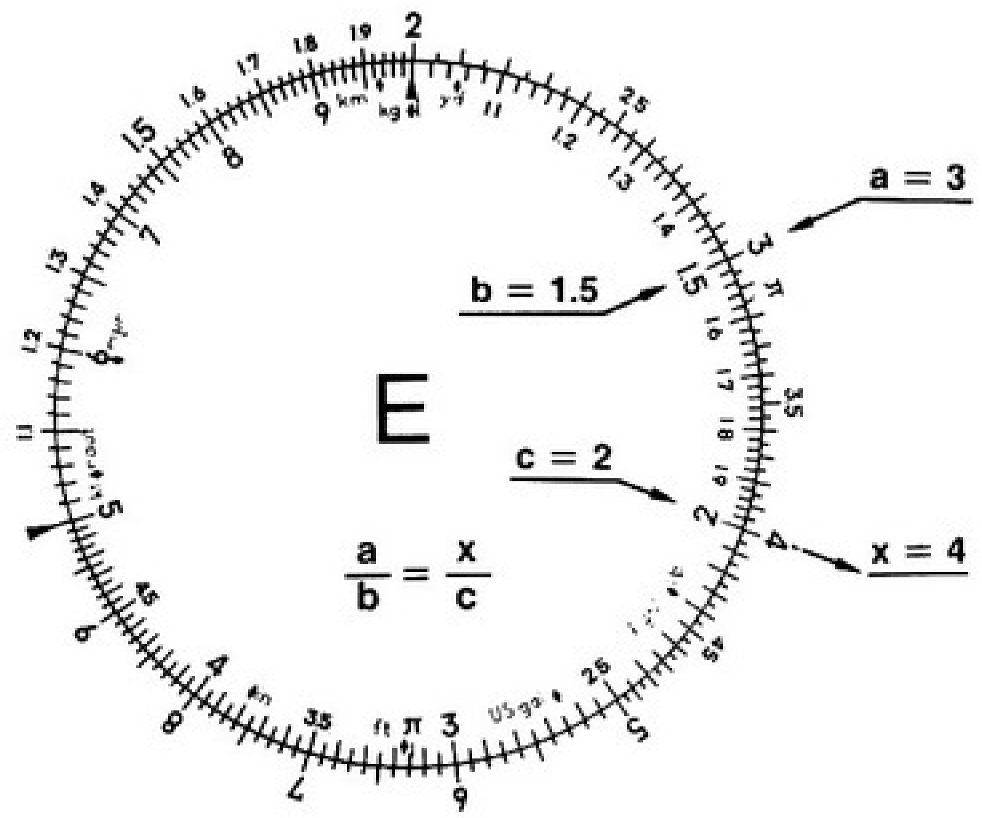
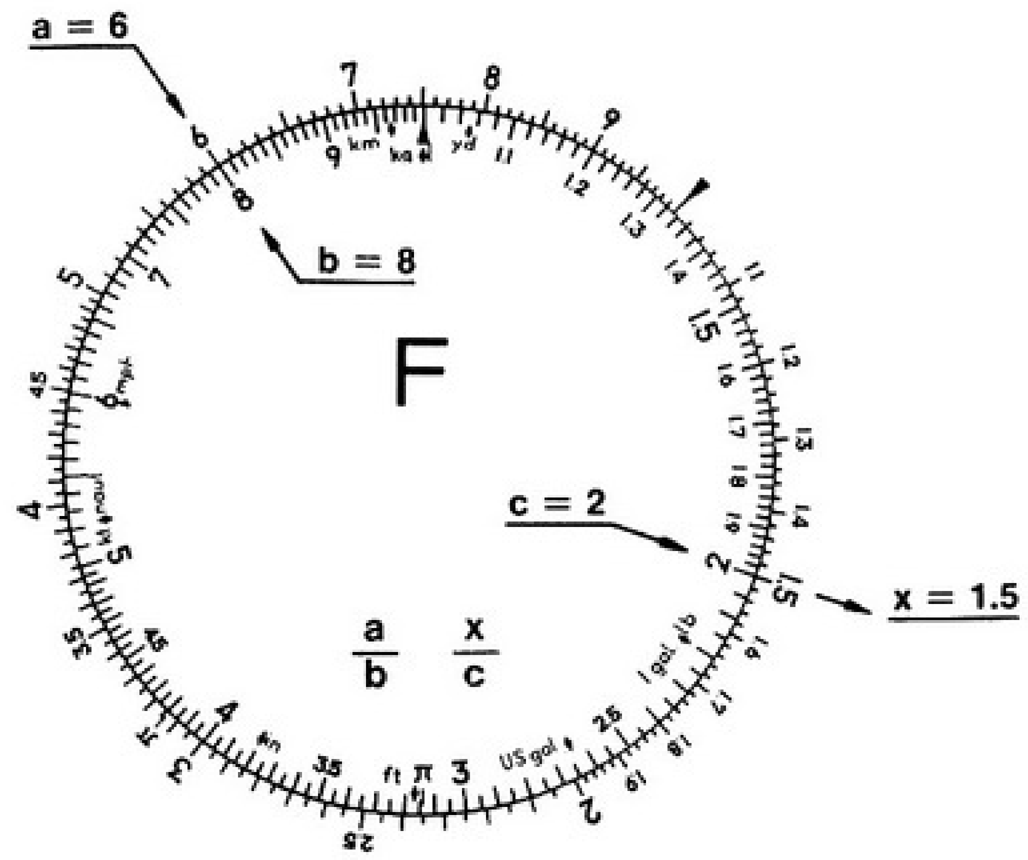


Diagram F



If, when the scales are followed clockwise from the first to the second position, the mark ▼ is found once on the outer ring (or the mark ▲ on the inner ring), the mark in question and the following numbers must be multiplied by 10. The result x is 10 times greater (or 10 times smaller) than the number which is read off. Cf. diagram G (or diagram H).

Diagram G

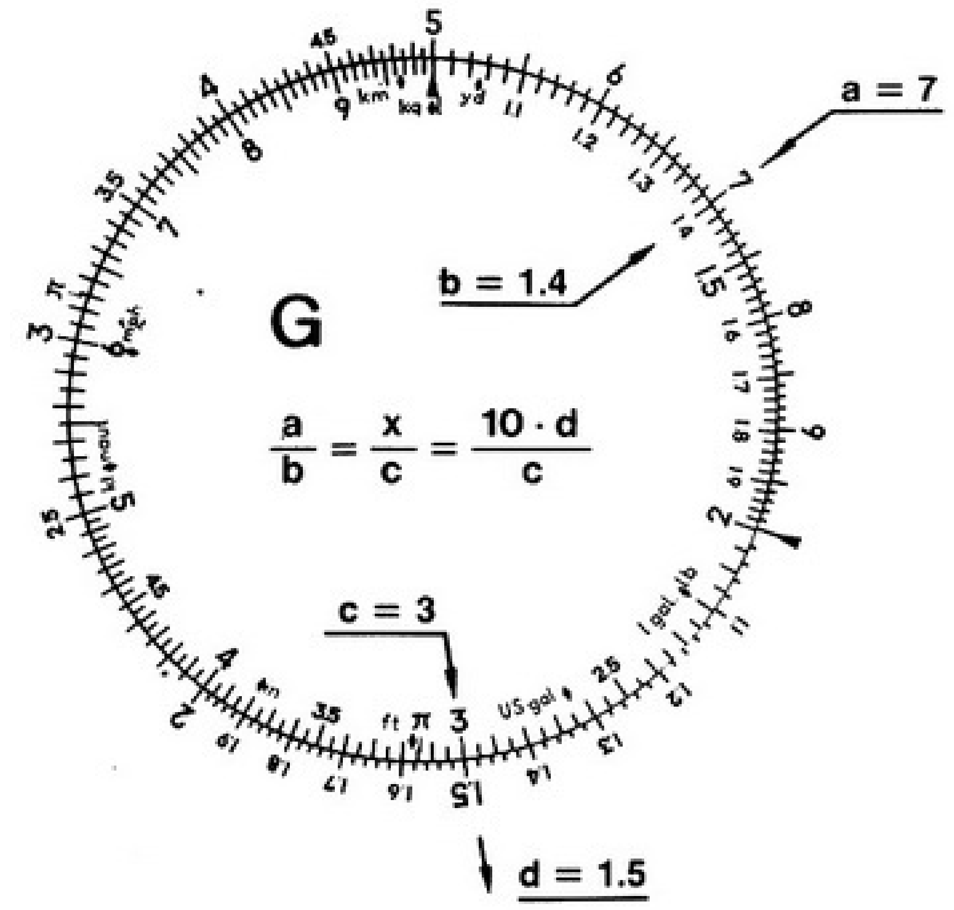
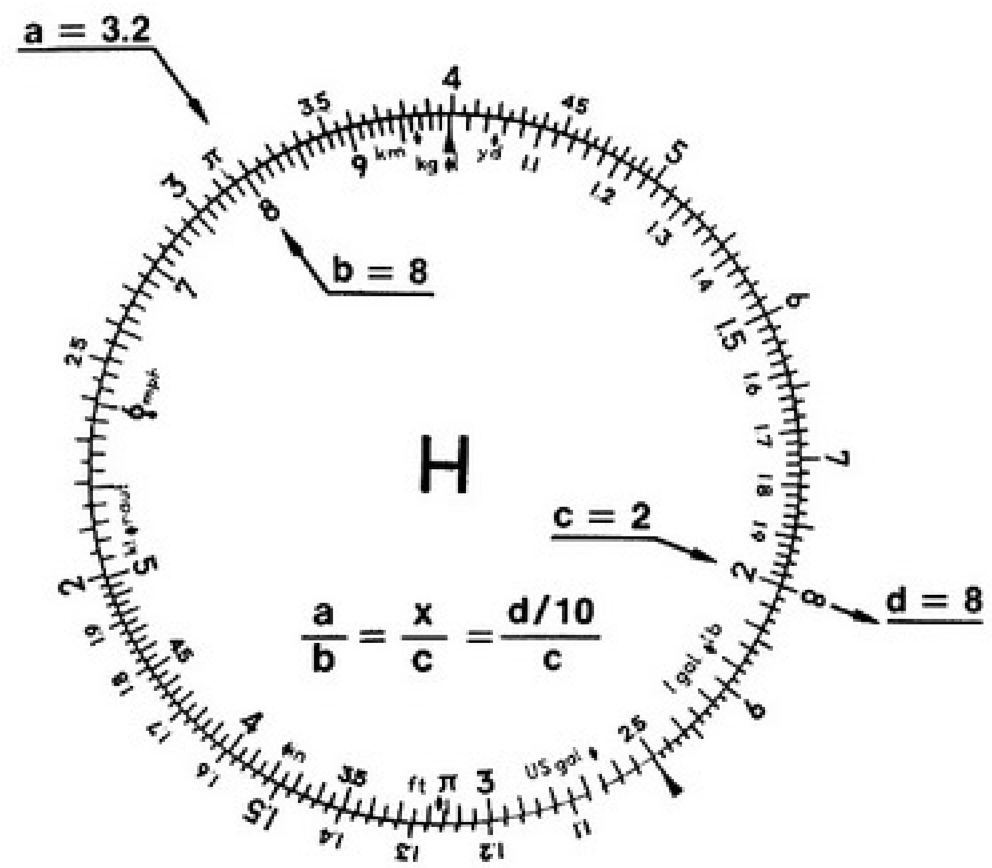


Diagram H



Note: when the ring is in any given position, all pairs of opposite numbers form the same proportion.

For example: if the number 2 on the outer ring is set opposite to the mark ▲, it will be found that the numbers forming the pairs 4/2, 5.6/2.8, 6.3/3.15, etc., are opposite to one another.
For the same setting, the following proportions serve to illustrate the position-value rule:
$9:4.5 = (1.2 \times 10):6$
$1.8:9 = 2.2:(1.1 \times 10)$

Square root $z = \sqrt{a}$

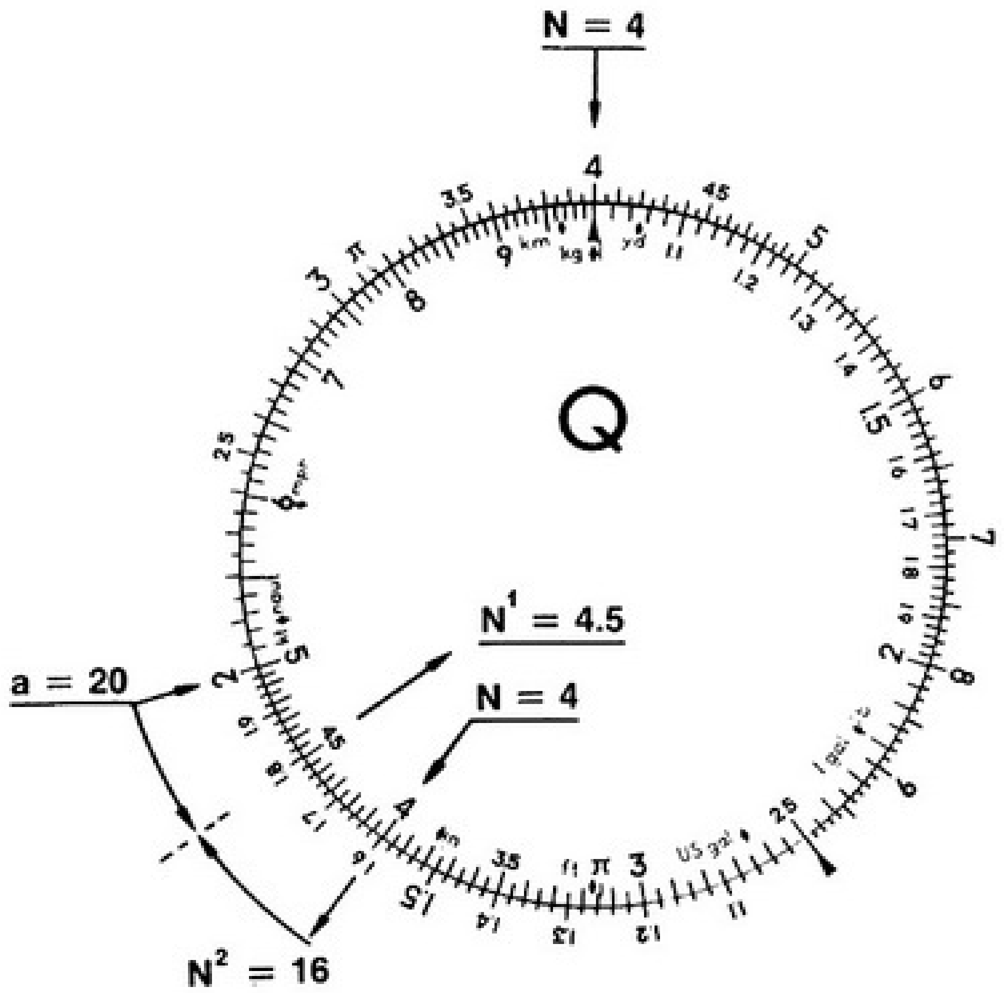
This equation is equivalent to the proportion $\frac{a}{z} = \frac{z}{1}$

Start with an approximate solution N. Find the number N on the outer circle and turn the ring until N is above the mark ▲; also find the number N on the inner scale; the number N^2 will be found opposite to it on the outer circle.

If N^2 coincides with a, the problem is solved: $N = \sqrt{a}$

There is generally a gap between N^2 and a. Estimate the middle of this gap and note its position on the inner scale, N_1; then turn the outer ring until the number a is opposite to this middle point.
If this has been done correctly, N_1 will also be at the top, above the mark ▲, and then $N_1 = \sqrt{a}$. If the middle point has not been correctly estimated, a closer approximation value for $\sqrt{a}$ will be found above the mark▲; the process can then be repeated on the basis of this new approximation.

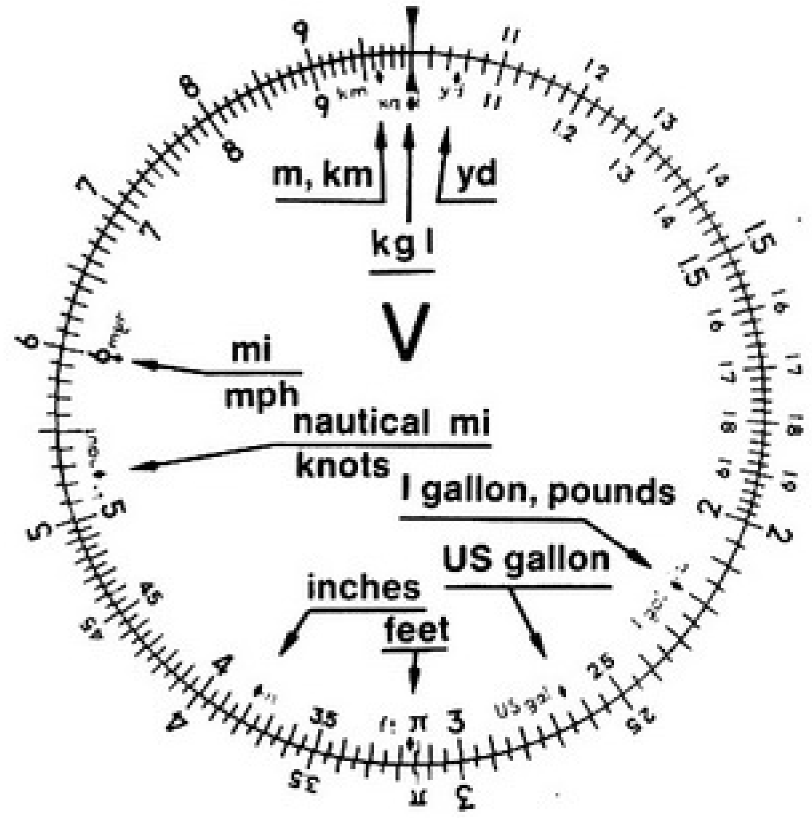
Diagram Q



Conversion of measurements

For the conversion of different measurements, the inner scale is marked with dots accompanied by abbreviations of the units concerned (cf. diagram V).

Diagram V



Conversion is effected as follows:
Find the value of the given measurement on the outer ring and set it opposite to the dot indicating the given unit of measurement.
The value which is sought will be found on the outer ring, opposite to the dot indicating the required unit of measurement.

The following equivalent values have been used:

Length
1.000 naut. mile = 1.151 stat. mile = 1.852 km = 2,025 yds = 6,076 ft = 72,913 in
0.865 naut. mile = 1.000 stat. mile = 1.610 km = 1,760 yds = 5,280 ft = 63,360 in
0.540 naut. mile = 0.621 stat. mile = 1.000 km = 1,094 yds = 3,281 ft = 39,370 in

Velocity
10.00 kn = 11.51 mph = 18.52 km/h = 0.182 mpmin
8.65 kn = 10.00 mph = 16.10 km/h = 0.167 mpmin
0.54 kn = 6.21 mph = 10.00 km/h = 0.103 mpmin
0.52 kn = 6.00 mph = 9.65 km/h = 0.100 mpmin

Capacity
1.000 imp. gal = 1.200 US gal = 4.546 l
0.833 imp. gal = 1.000 US gal = 3.785 l
0.220 imp. gal = 0.264 US gal = 1.000 l

Weight
1.0 lb = 0.454 kg
2.2 lb = 1.000 kg

Examples of multiplication

Foreign exchange

Suppose the rate of exchange of the DM is 118. 100 DM therefore cost 118 SFr. How much will 750 DM cost?

Conversion with the Heuer Calculator (Fig. 1)

As only the numbers from 1 to 10 are indicated on the scales, workout 1.18 times 7.5 and multiply the result by 100 in your head.

Set the ring so that 1.18 is at the top, opposite to the mark ▲. Find the number 7.5 on the inner scale and read off the result (8.85) on the ring. Thus 750 DM will cost 885 SFr.
It is to be noted that the outer ring does not has to be reset for further conversions at the same rate of exchange.
Thus it is found, for example, that 300 SFr. = 254 DM.

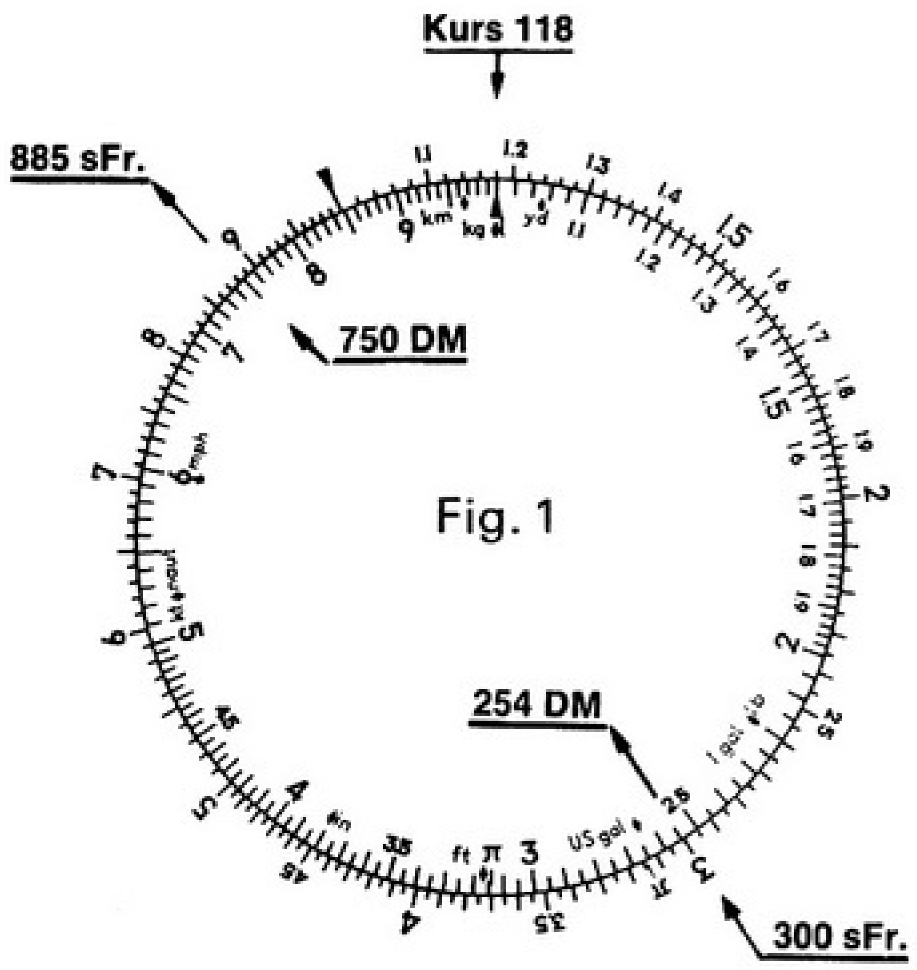


Fig. 1

Calculating percentages (Fig. 2)

Someone buys a machine costing Fr. 1,600.– and has to pay 7.5 % import duty on the value. What is the amount of the import duty?

Calculation with the Heuer Calculator

Set the number 7.5 on the outer ring opposite to the mark ▲, then find the number 1.6 on the inner scale. Opposite to this, on the outer ring, is the number 1.2. The import duty thus amounts to Fr. 120.–.

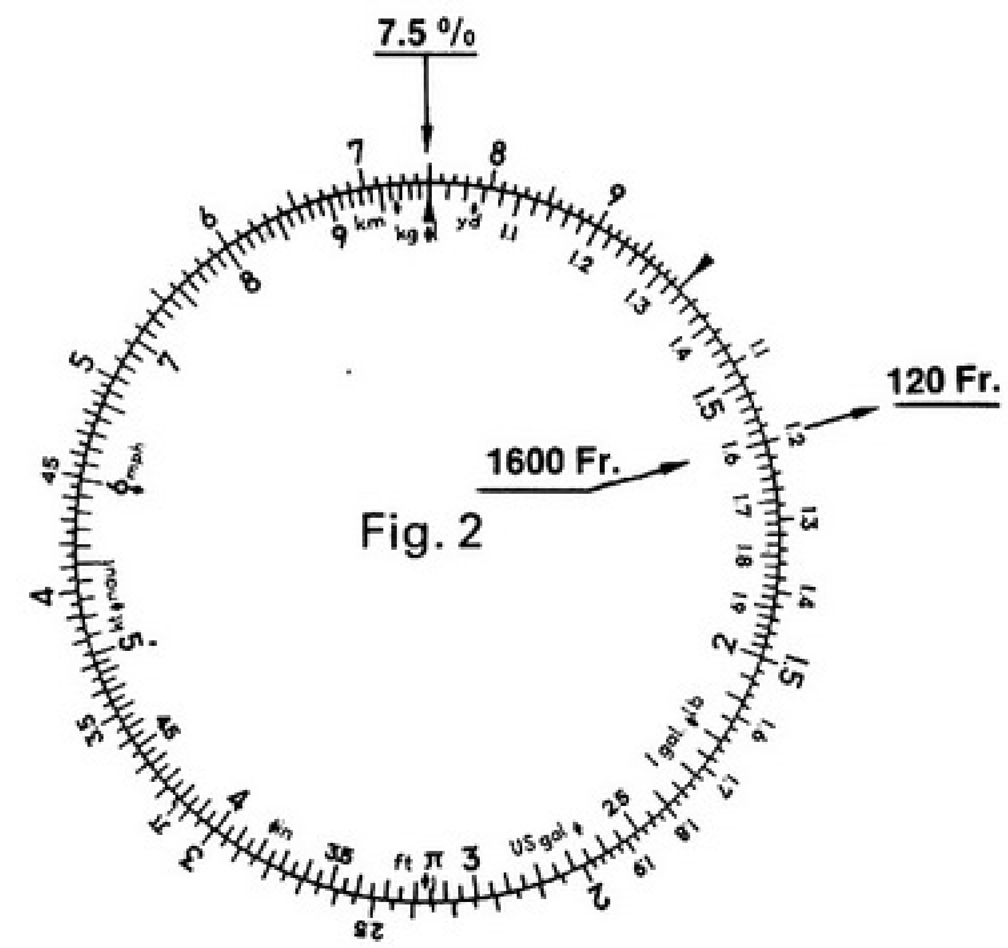


Fig. 2

Distance travelled by sound (Fig. 3)

7.3 seconds elapse between a lightning flash and the first clap of thunder. The distance of the lightning flash is 340 m/s multiplied by 7.3 s.

Calculation with the Heuer Calculator

Set the number 3.4 on the outer ring opposite to the mark ▲. Opposite to the number 7.3 on the inner scale, you will read 2.48. The distance of the lightning flash is therefore 2.48 km.
For further measurement of distances travelled by sound, leave the outer ring set as it is and read the number indicating each new distance at the corresponding point on this ring.

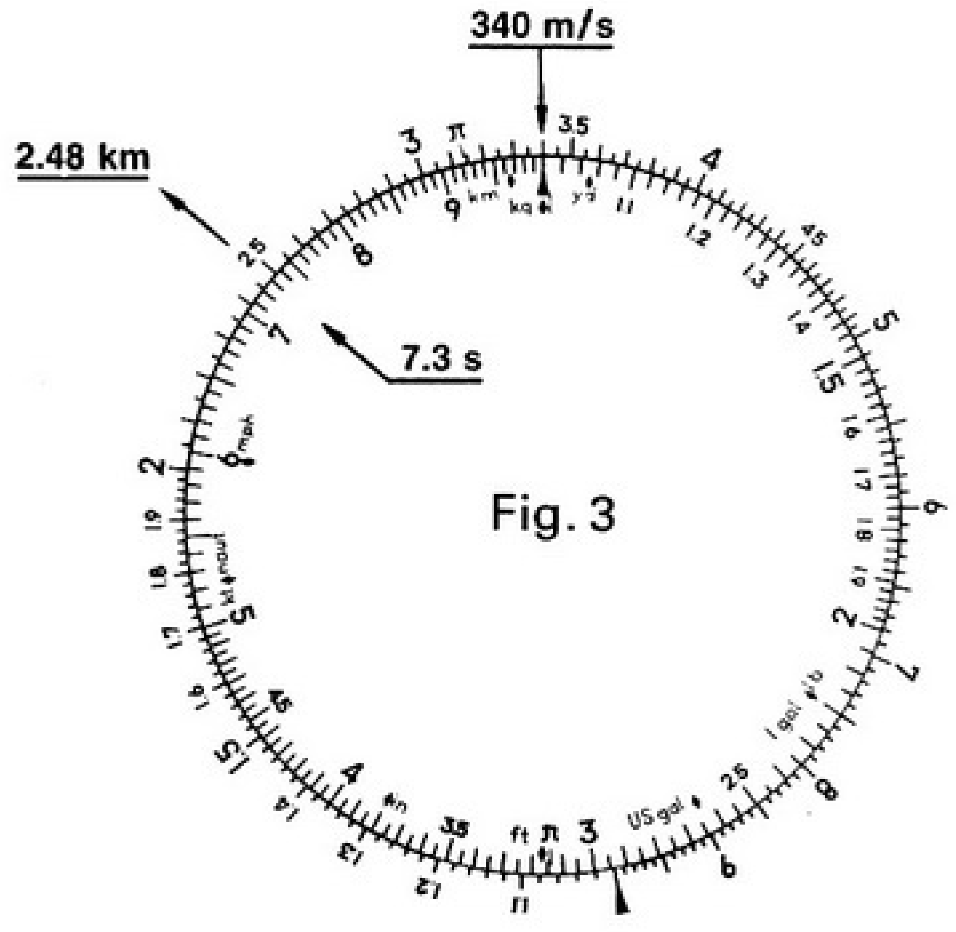


Fig. 3

Circumference of a wheel (Fig. 4)

A wheel is 61 cm in diameter. What is its circumference? The circumference of a circle is equal to the diameter multiplied the factor π.

Calculation with the Heuer Calculator

Turn the outer ring until 6.1 is above the mark ▲. The mark for π is close to 3.1_4 at the bottom of the inner scale. Opposite to this mark, on the outer ring, you will find the number 1.9_{15}. Thus the circumference is 1.9_{15} m.

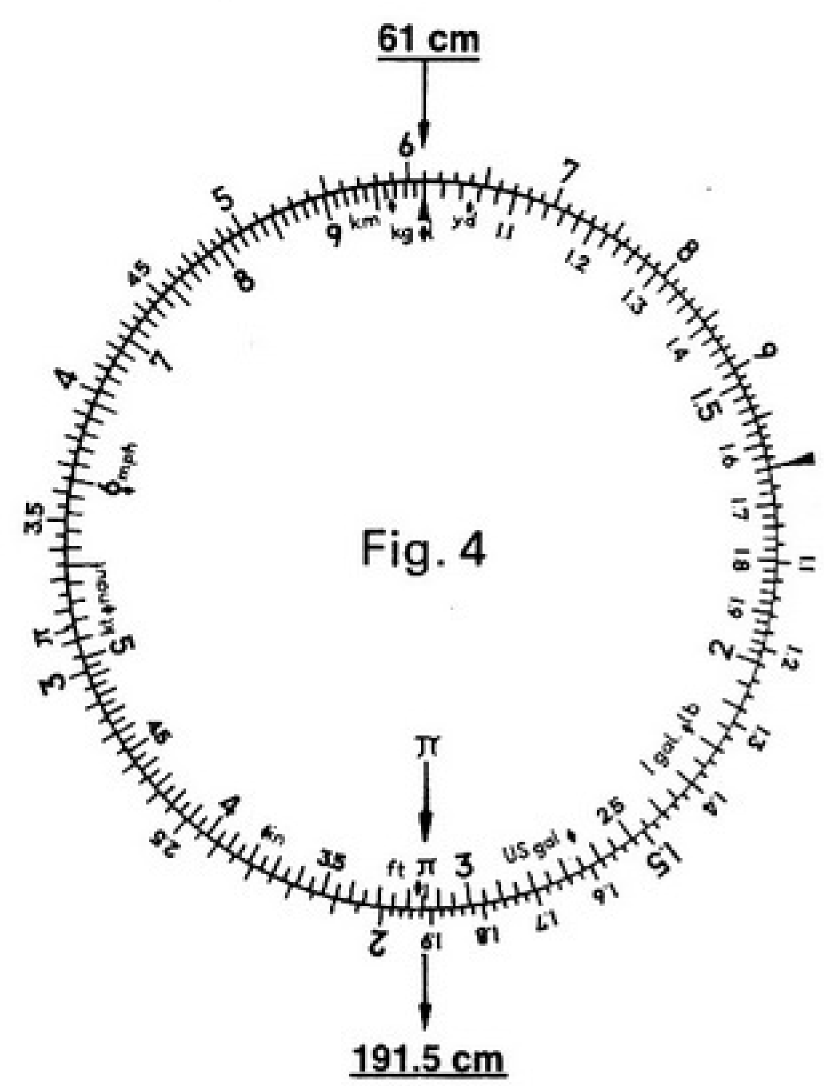


Fig. 4

Quantities of water (Fig. 5)

A fountain delivers 4.5 l of water per minute. How much will it deliver in an hour (= 60 min)?

Calculation with the Heuer Calculator

Turn the ring until the number 6.0 is at the top, above the mark ▲. Then follow the inner scale clockwise as far as the number 4.5; in doing this, you will pass once over the mark ▼ on the outer ring. This means that the number 2.7 which is read off on this ring must be multiplied by 10. The fountain therefore delivers 27 l of water in 6 minutes, or 270 l in an hour.

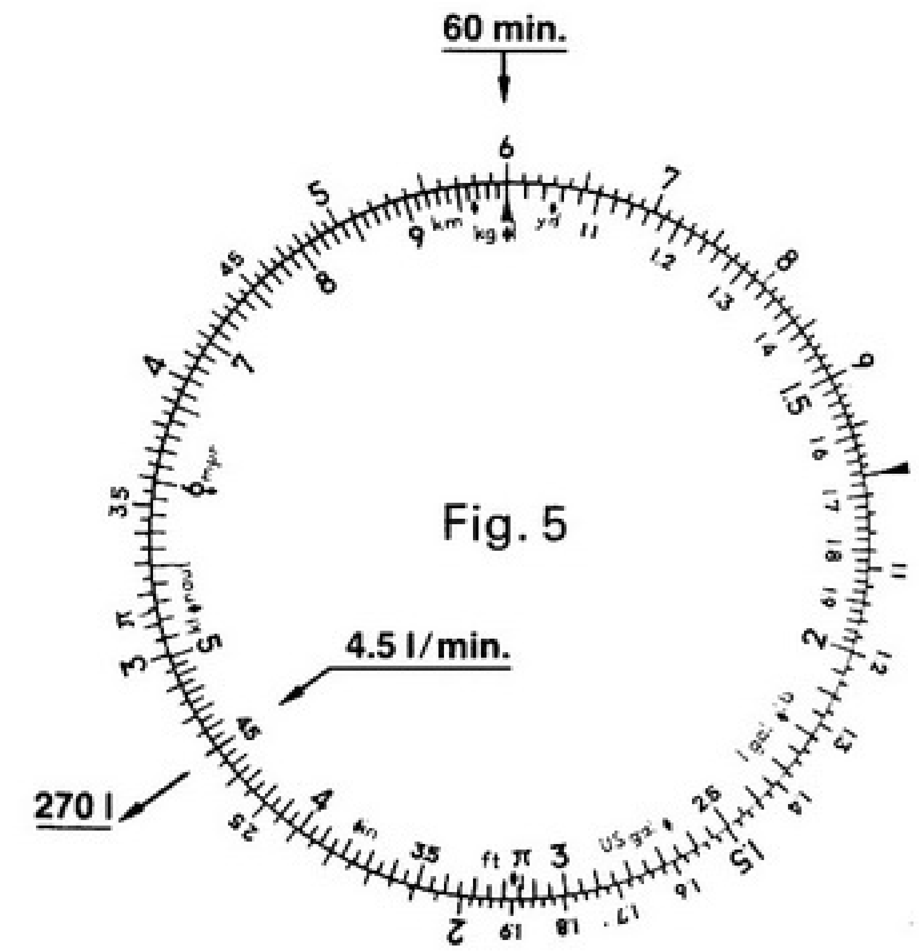


Fig. 5

Consumption of electric energy and its cost (Fig. 6/6a)

The power of an electric radiator is 1.8 kW. A room is heated with this radiator for 4 h 15 min = 4.25 h. How much energy is consumed, and what does it cost at the rate of 12 c. per kWh?
To obtain the energy in kWh, it is necessary to multiply 4.25 by 1.8, and the result must then be multiplied by 12 c./kWh to give the cost.

Calculation with the Heuer Calculator

Find the number 4.25 on the outer ring, then turn the ring until that number is above the mark ▲. Find the number 1.8 on the inner scale; the number opposite to this on the outer ring is 7.6_5. The energy consumption is therefore 7.6_5 kWh. Now set 7.6_5 above the mark ▲ and find the number 1.2 on the inner scale. The number 9.2 can be read off on the outer ring. The energy consumed therefore costs 92 c.

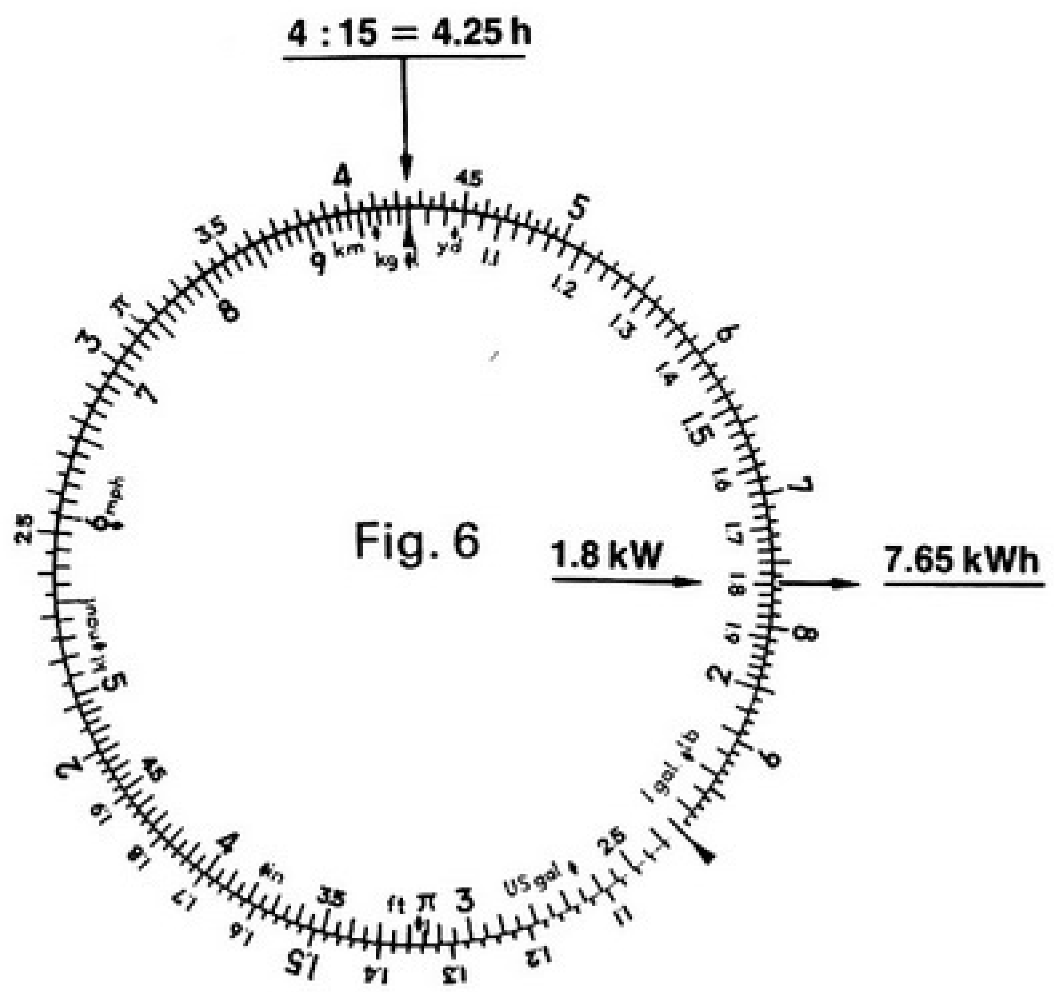


Fig. 6

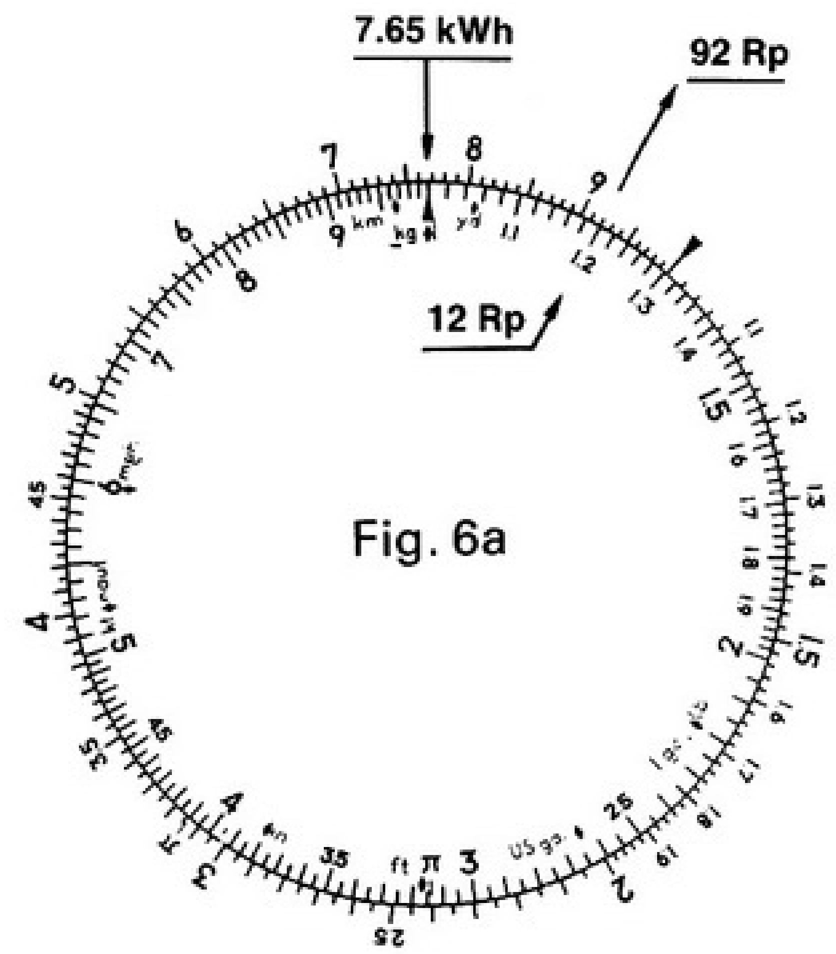


Fig. 6a

Section of a wire (Fig. 7/7a)

The diameter d of a wire is 2.3 mm. How large is the section S?

$S = \frac{\pi}{4} d^2$

Calculation with the Heuer Calculator

We start by calculating d^2. To do this, find the number d = 2.3 on the outer ring, then turn the ring to set the number 2.3 above the mark ▲. Find the number 2.3 on the inner scale and read off the number opposite to it on the outer ring, viz. 5.29.
Now turn this ring until the number 5.29 is above the mark ▲. Then find $\frac{\pi}{4} = 0.78_5$ on the inner scale and read off the result on the outer ring, viz. 4.14. The section of the wire amounts to 4.14 mm^2.
If this calculation has to be repeated frequently, it is a good thing to mark the position $\frac{\pi}{4} = 0.78_5$ with a pencil.

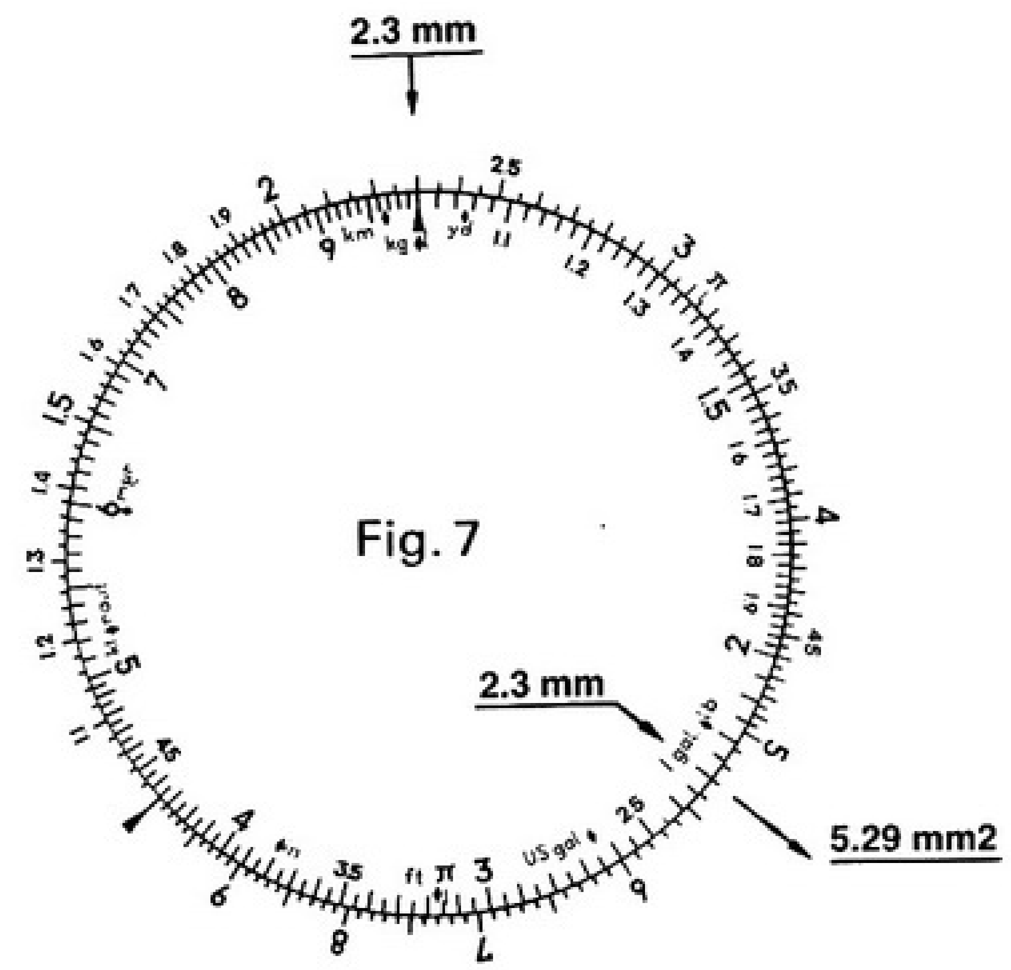


Fig. 7

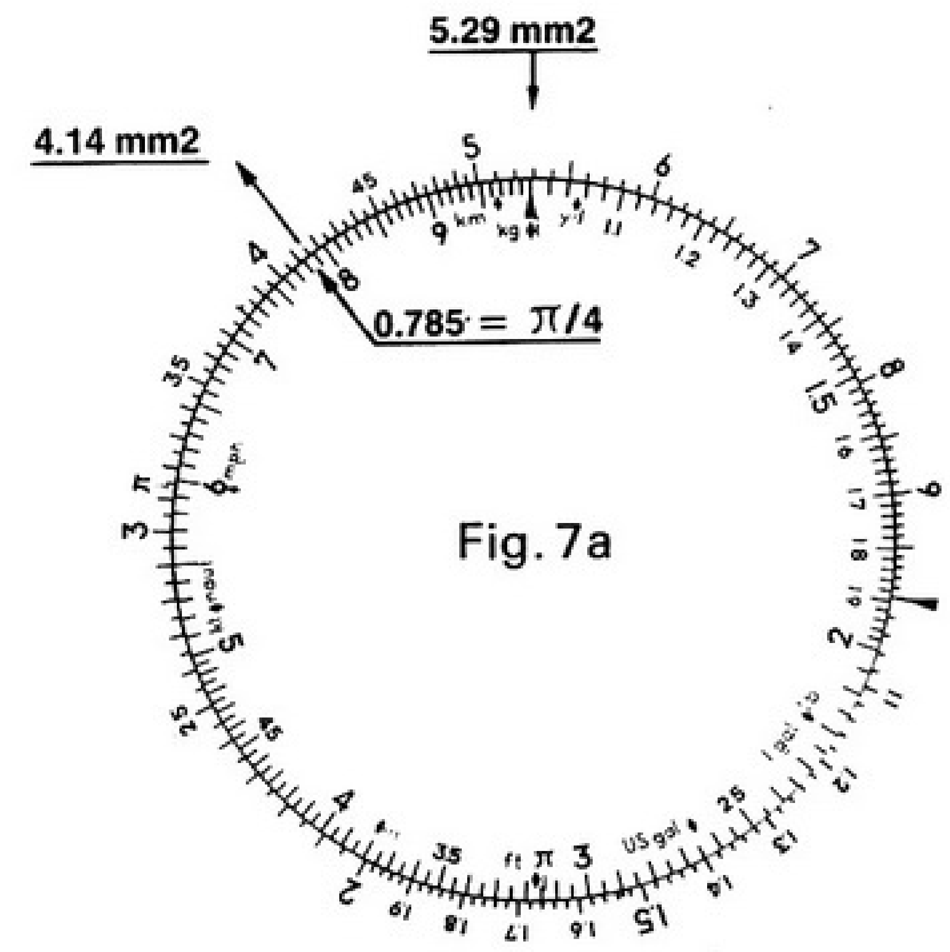


Fig. 7a

Examples of division

Climbing-time of an aircraft (Fig. 8)

An aircraft climbs at the rate of 500 ft per minute. How long will it take to reach an altitude of 3,600 ft?

Calculation: $\frac{3{,}600 \text{ ft}}{500 \text{ft/min}}$

Set 3.6 opposite to the number 5 and read off the result at the top. It takes 7.2 min.

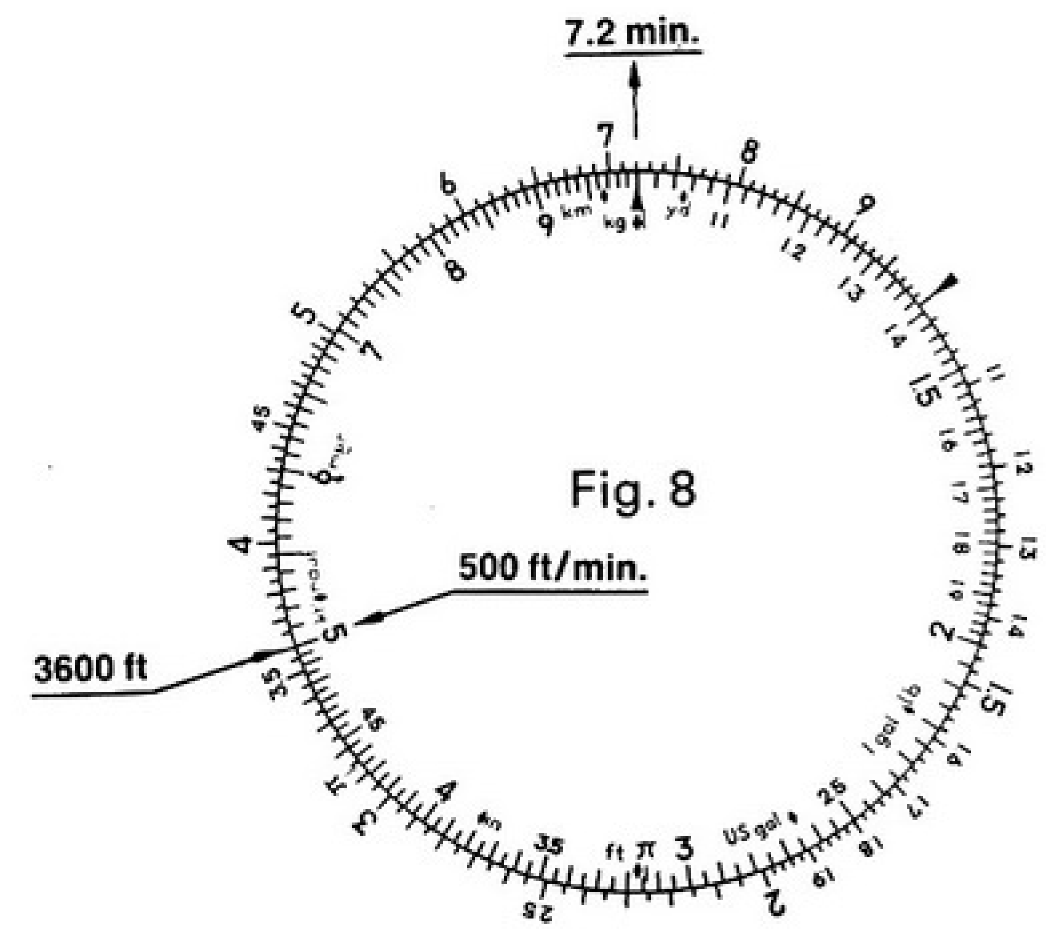


Fig. 8

Rate of descent of an aircraft (Fig. 9)

An aircraft descends 6,000 ft in 15 min. What is the rate of descent per minute?
Set the number 6 on the outer ring opposite to the number 1.5 on the inner scale and read off the result, viz. 4, above the mark ▲.
6,000 ft in 15 min = 400 ft per minute.

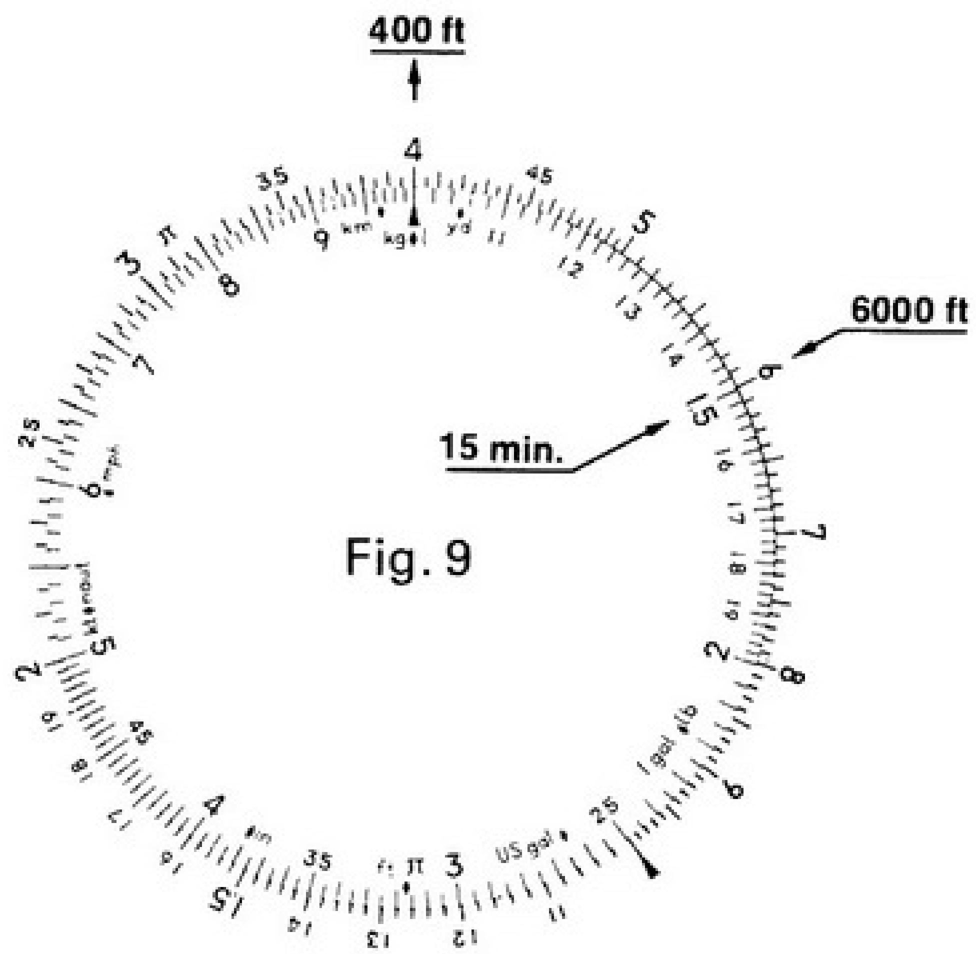


Fig. 9

Number of revolutions of a wheel (Fig. 10)

The circumference of an automobile tyre is 1.9 m. How many revolutions are made by the wheel when the car travels 1 km?
The number of revolutions = 1 km divided by 1.9 m.

Calculation with the Heuer Calculator

Set the mark ▼ (=1 km) on the outer ring opposite to the number 1.9 on the inner scale. The reading over the mark ▲ is 5.2_5. The wheel of the automobile therefore makes 525 revolutions in travelling 1 km.

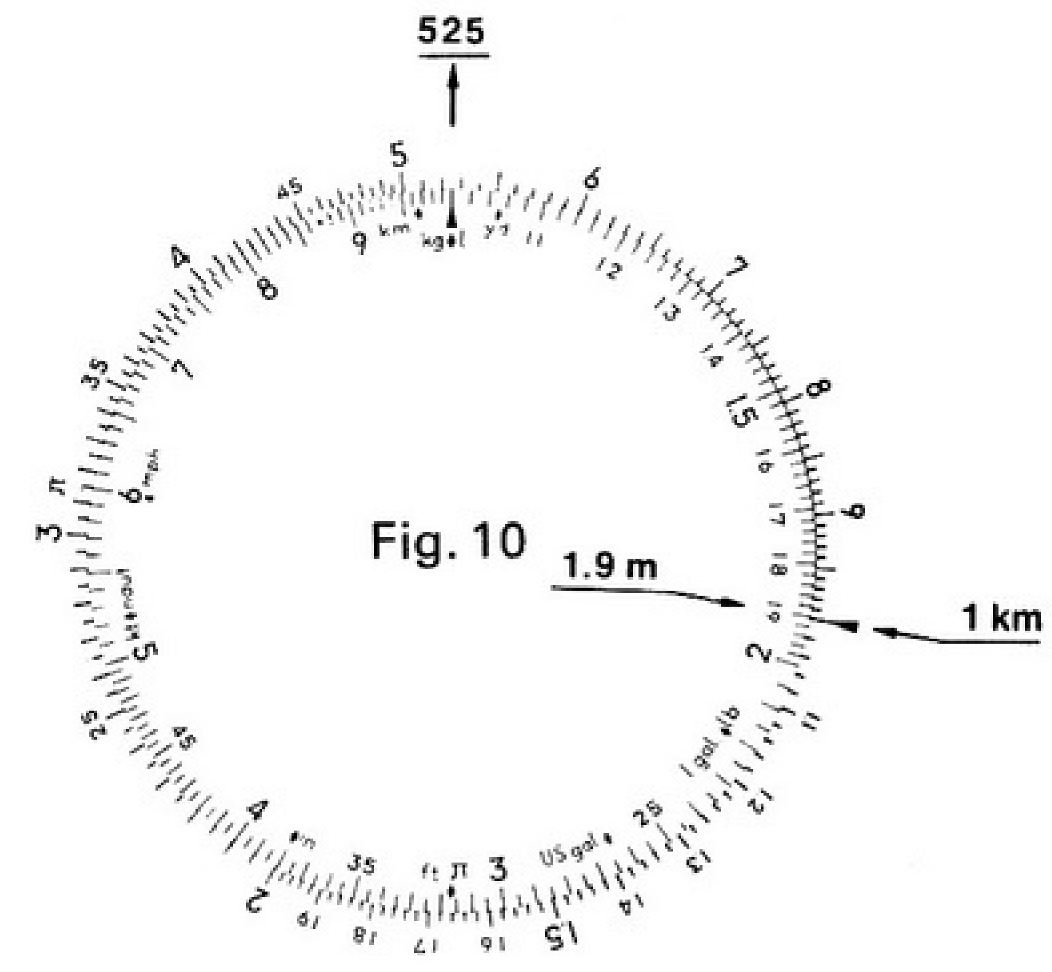


Fig. 10

Example of rule-of-three calculation

Checking a speedometer (Fig. 11)

A motorist knows that two given road junctions are 480 m apart. He wishes to check his speedometer. Using the Heuer Calculator, he finds that he takes 25 s to cover the 480 m. The speed equals the distance travelled, divided by the time taken, viz. 480 m divided by 25 s.

Calculation with the Heuer Calculator

Set the number 4.8 on the outer ring opposite to the number 2.5. The value 1.92 is then above the mark ▲. As the meter is calibrated in units of 100 m and the denominator is reckoned in units of 10 s, the result is 100 m × 1.92 divided by 10 s = 19.2 m/s.
Without turning the ring, find the number 3.6 on the inner scale and read the number on the outer ring, viz. 6.9. The speed of the car is therefore 69 km/h. Opposite to the number 6 (60 s), the speed is indicated as 1.15 km/min.

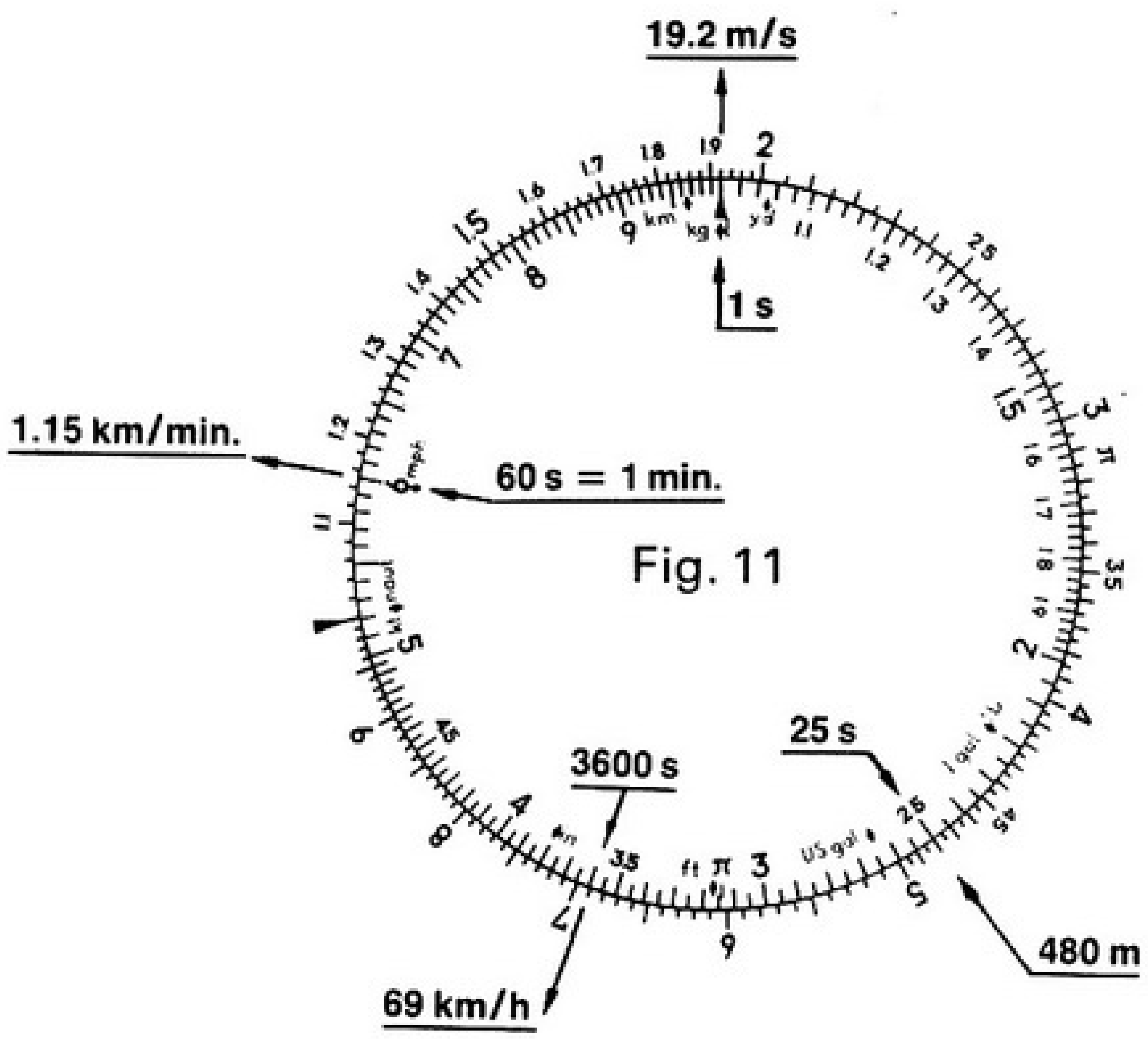


Fig. 11

Speed of an athlete (Fig. 12)

An athlete takes 11.3 s to run 100 m. What is his average speed?

Calculation with the Heuer Calculator

100 m must be divided by 11.3 s. Set the mark ▼ on the outer ring opposite to the number 1.13 and read the number shown above the mark ▲, viz. 8.85. The athlete's average speed in therefore 8.85 m/s.
As 1 m/s = 3.6 km/h, the number 3.18 can be read off under the number 3.6 (inner scale) when the ring is set in the same position. This shows that the athlete's average speed is 31.8 km/h.

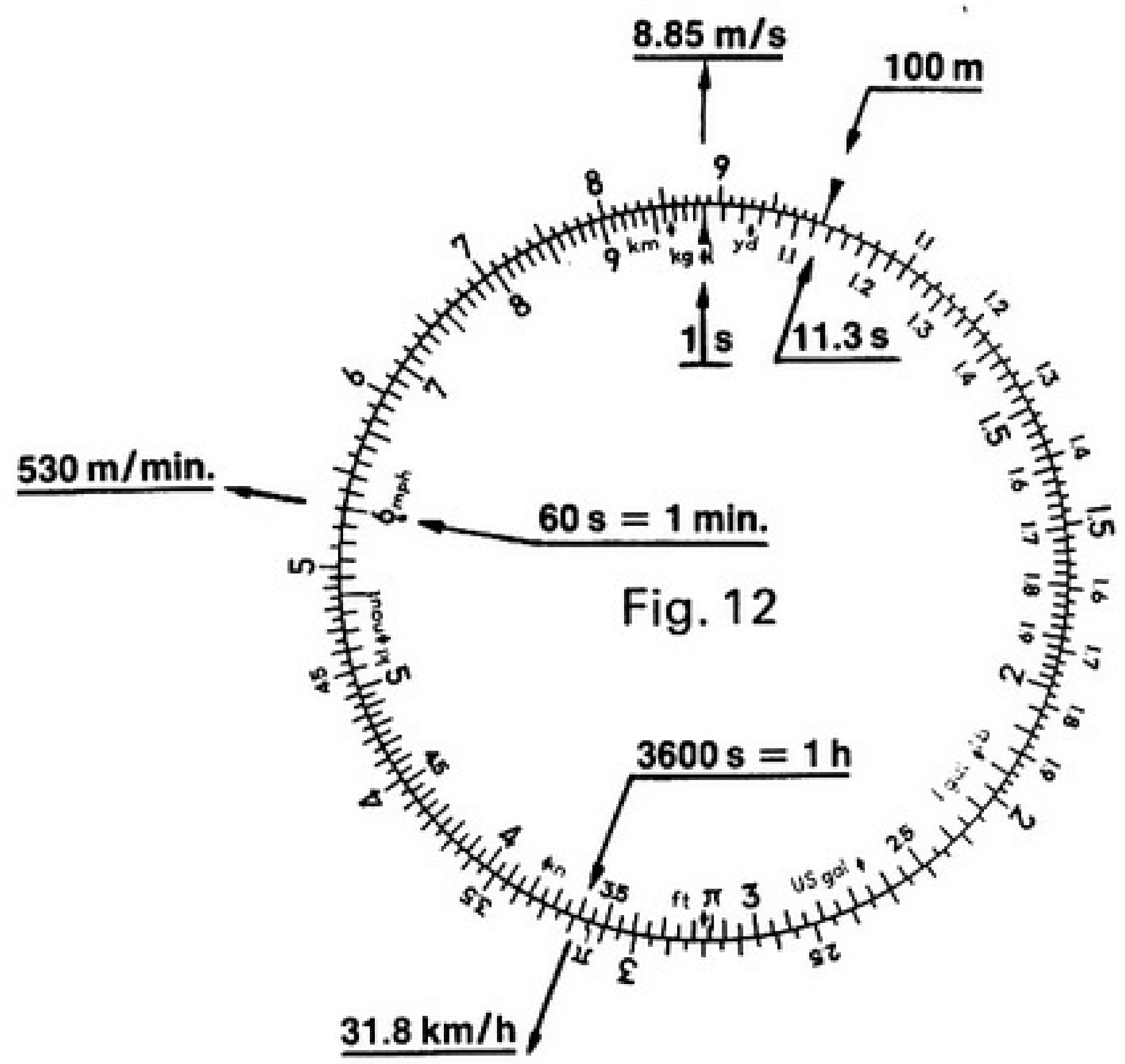


Fig. 12

Fuel reserve (Fig. 13)

A pilot starts off with 50 US gal of fuel in his tank. After $2\frac{1}{2}$ hours, his fuel gauge shows that he still has 30 US gal left. How long can he go on flying before refuelling?

He consumes $\frac{20\ \text{gal}}{2.5\ \text{h}} = \frac{30\ \text{gal}}{?\ \text{h}}$

He sets the number 2 on the outer ring opposite to the number 2.5 on the inner scale. At the top, he reads 8 gal/h. Opposite to the number 3 on the outer ring, he reads 3.75. The 30 gal are sufficient for 3.75 hours' flying = 3 h 45 min.

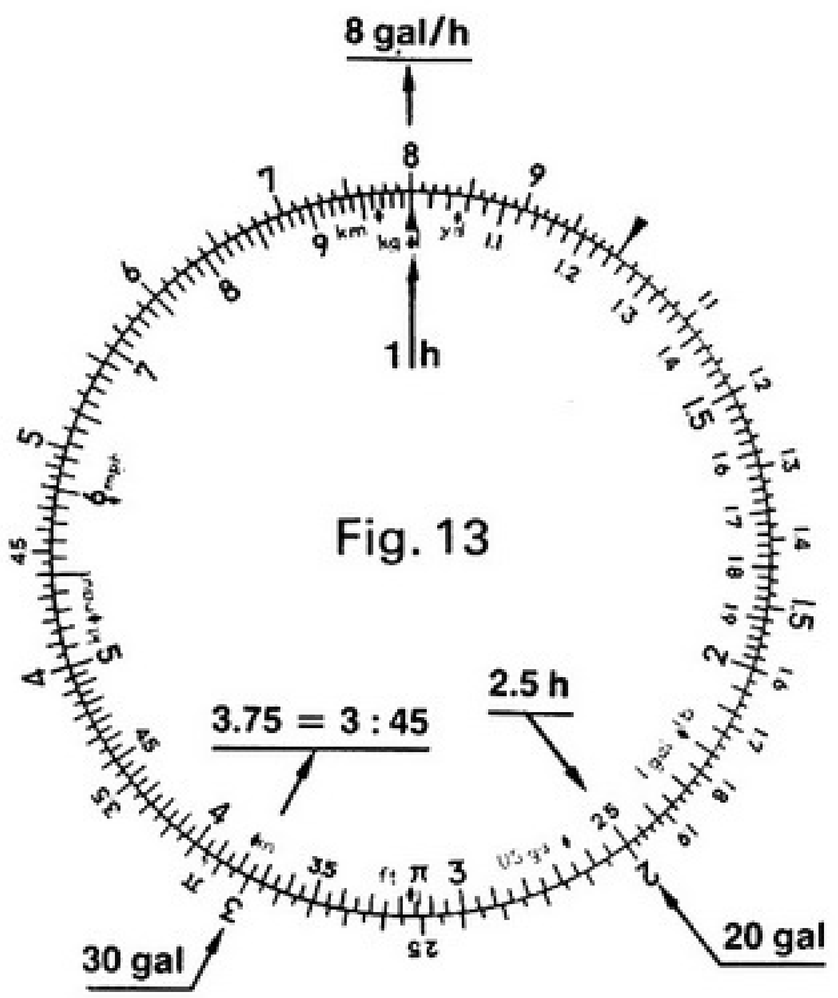


Fig. 13

Rowing (Fig. 14)

In a rowing-boat, 20 strokes are counted in 18 s. This makes how many strokes per minute?

Calculation with the Heuer Calculator

Set the number 2 on the outer ring opposite to the number 1.8 on the inner scale. The number 1.11 appears above the mark ▲.
The number 6.67 is opposite to the number 6 on the inner scale. Therefore the rate of stroking is 1.11 per second, or 66.7 per minute.

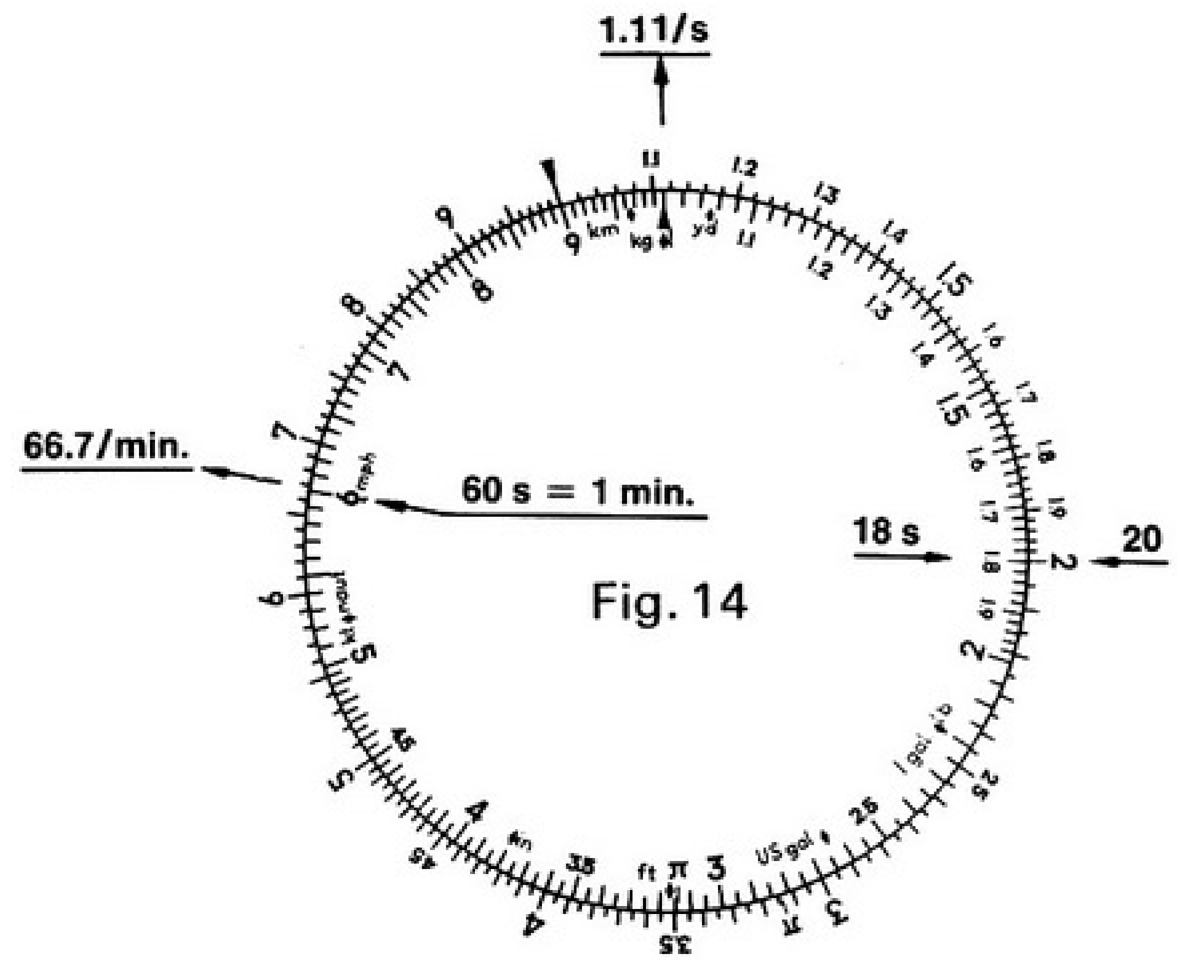


Fig. 14

Speed of a train (Fig. 15)

Using his Heuer Calculator, a passenger measures 37.6 s from one kilometre post to the next. What is the speed of the train?

Calculation with the Heuer Calculator

He sets the mark ▼ (1 km) opposite to the number 3.76 on the inner ring and reads 2.6_6 opposite to the mark ▲. With this setting, he has calculated 10 divided by $3.7_6 = 2.6_6$. 1 km divided by 37.6 s is required, and therefore the number read off is 100 times too large. The speed of the train is 0.026_6 km/s = $26._6$ m/s.
The passenger knows that 1 m/s = 3.6 km/h. Without turning the ring, he finds the number 3.6 on the inner scale; opposite to it, he sees the number 9.5_8. The train is travelling at $95._8$ km/h.
If the passenger wishes to repeat the calculation several times, he can mark the inner scale with pencil, close to the number 3.6.

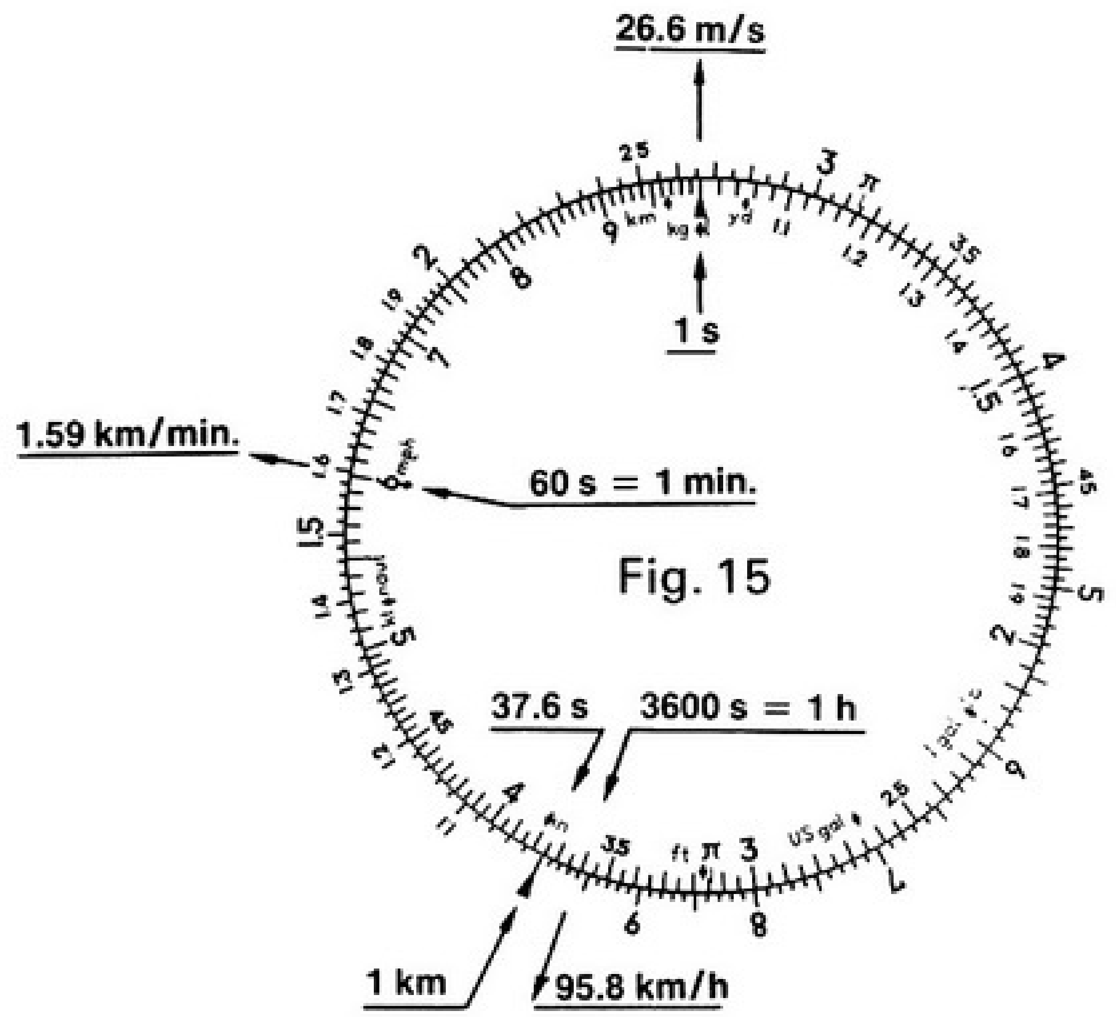


Fig. 15

Distance flown by an aircraft (Fig. 16)

How far does an aircraft fly in 16 min if its speed is 120 miles per hour?
Calculation: The miles per hour must be converted into miles per minute, and the result must be multiplied by 16. Set the number 1.2 on the outer ring opposite to the number 6 (mph). The number 2 will be seen above the mark ▲.
120 mph = 2 mpmin. With the same setting, the number 1.6 is indicated opposite to the number 3.2.

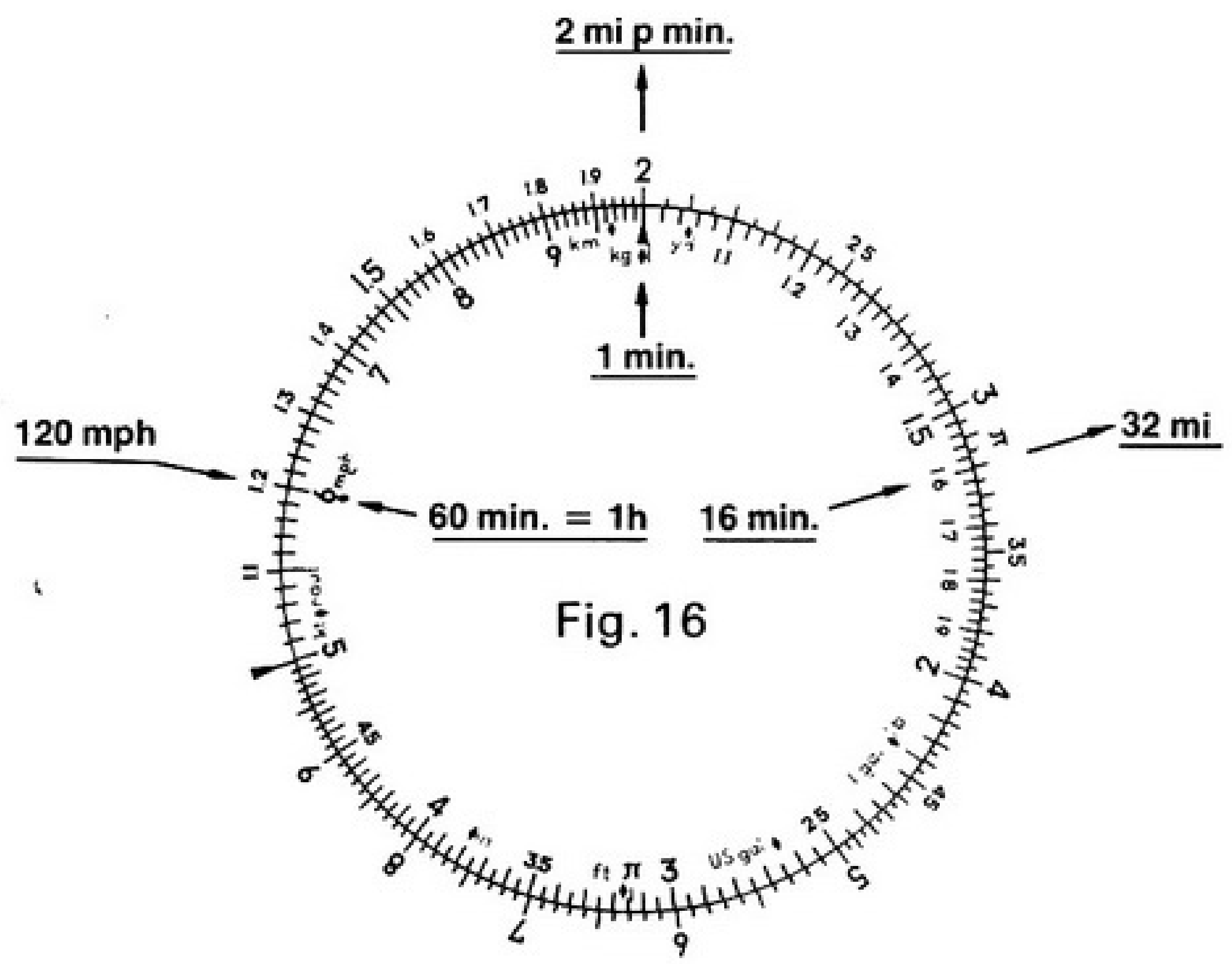


Fig. 16

Examples of the calculation of square roots (Fig. 17/17a)

Square root of 6

The value of $\sqrt{6}$ is to be ascertained.

Calculation with the Heuer Calculator

Take 2 as the first approximation value and set the number 2 on the outer ring opposite to the mark ▲. Opposite to the number 2 on the inner scale is the number 4 on the outer ring. The middle of the arc between 4 and 6 is situated approximately at 5. On the inner scale, the number 2.5 is opposite to the 5. Turn the outer ring until the number 6 is opposite to the number 2.5; the number 2.4 will then be indicated above the mark ▲. Take 2.4 as the new approximation value. Without turning the ring, it will be seen that $2.4 \times 2.4 = 5.7_6$. The middle of the arc between 5.7_6 and 6 is approximately opposite to the number 2.45. Turn the ring until 6 and 2.45 are opposite to each other; the number 2.45 will then be indicated at the top, above the mark ▲.
Thus, calculated to the 2nd decimal place,

$\sqrt{6} = 2.45$

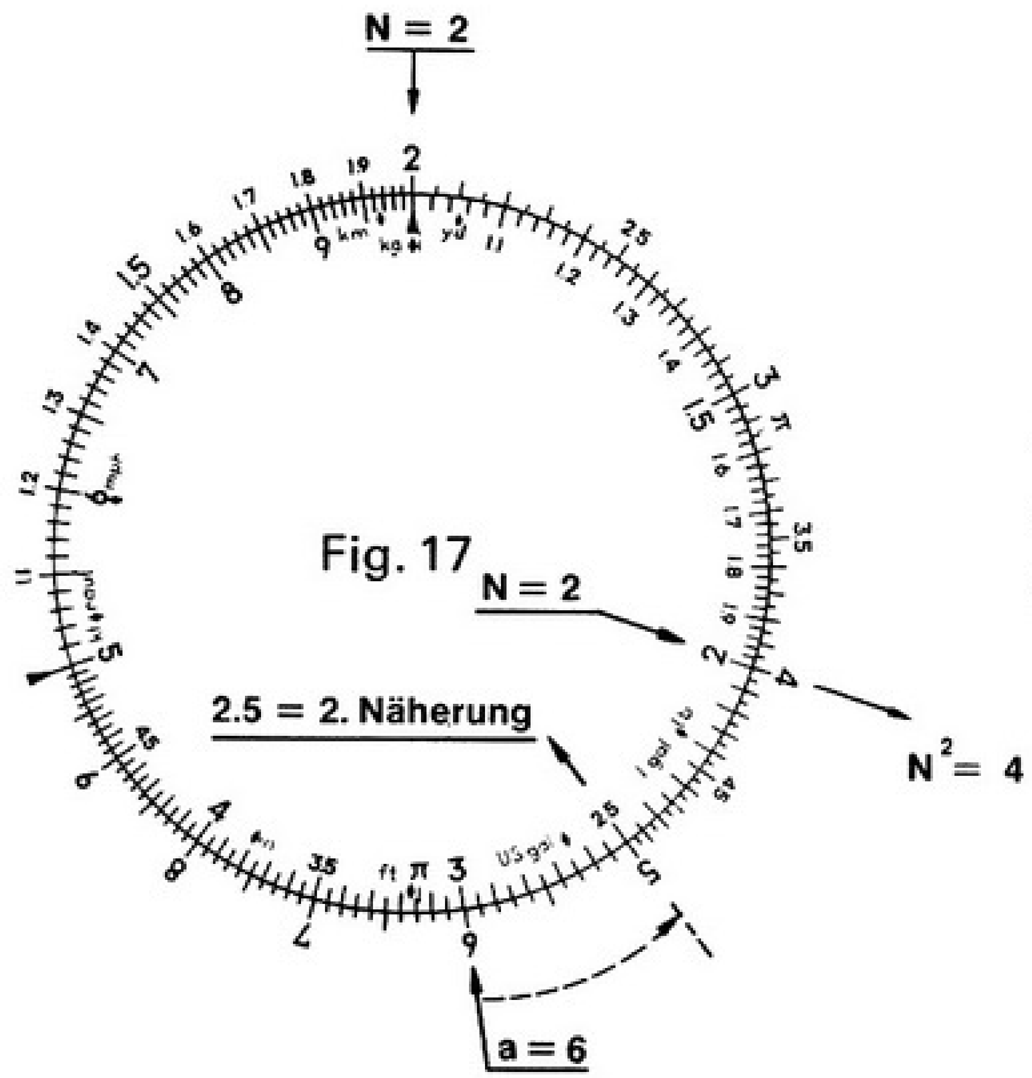


Fig. 17

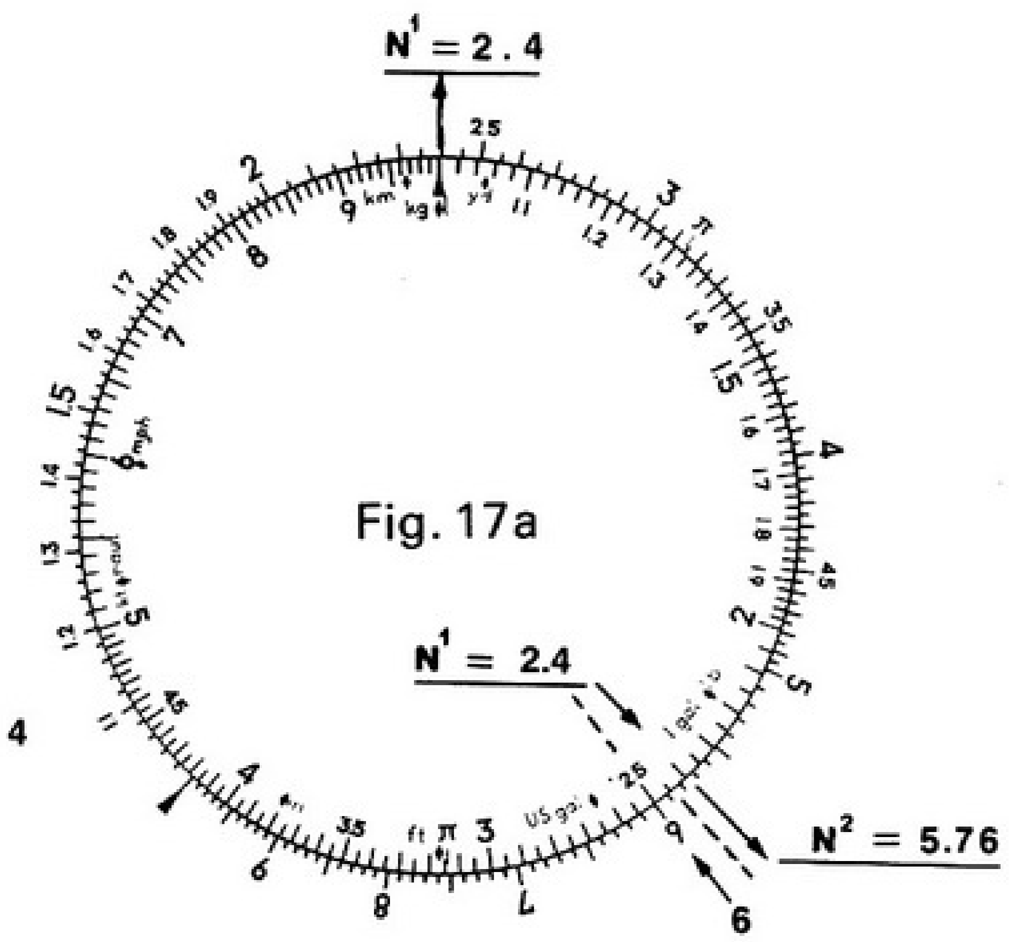


Fig. 17a

Diameter of a pipe of known section (Fig. 18/18a)

The section S of a pipe is 0.5 m². What is the diameter d of the pipe?

It is $S = \frac{\pi}{4} d^2$ $d^2 =$ S divided by $\frac{\pi}{4}$

Calculation with the Heuer Calculator

Set the number 0.5 on the outer ring opposite to the number $\frac{\pi}{4} = 0.78_5$. The number 6,38 will be seen above the mark ▲, therefore $d^2 = 0.638\ m^2$.
An approximation for d is 0.8, which is accurate enough. The diameter is 0.8 m.

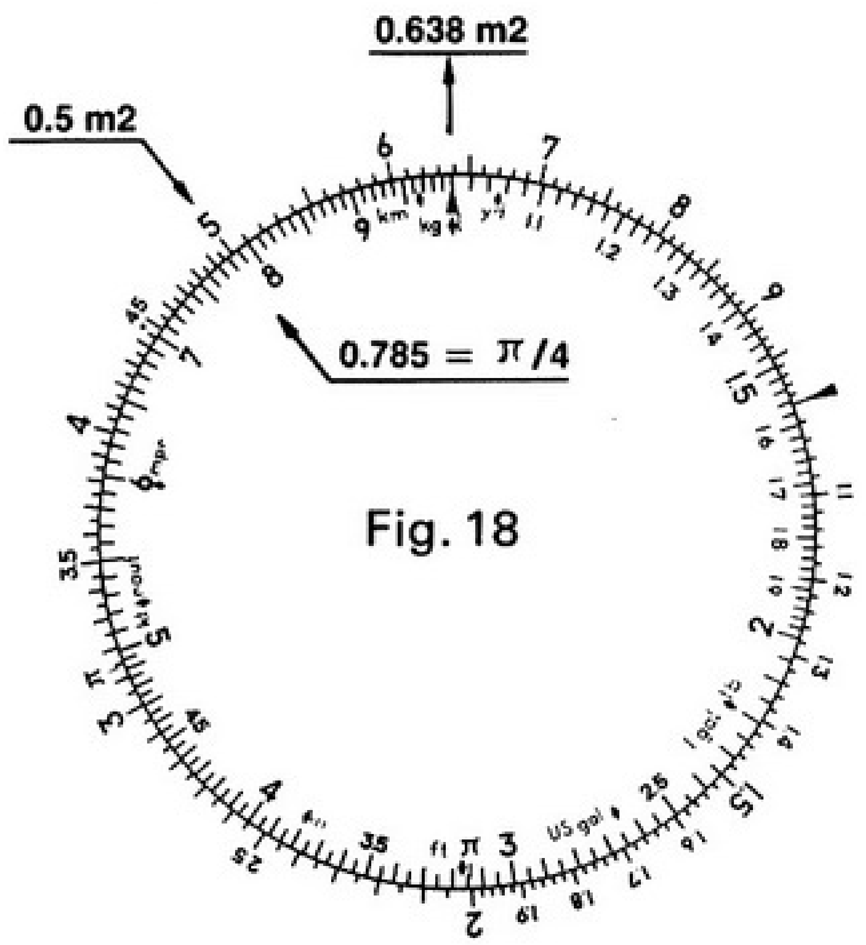


Fig. 18

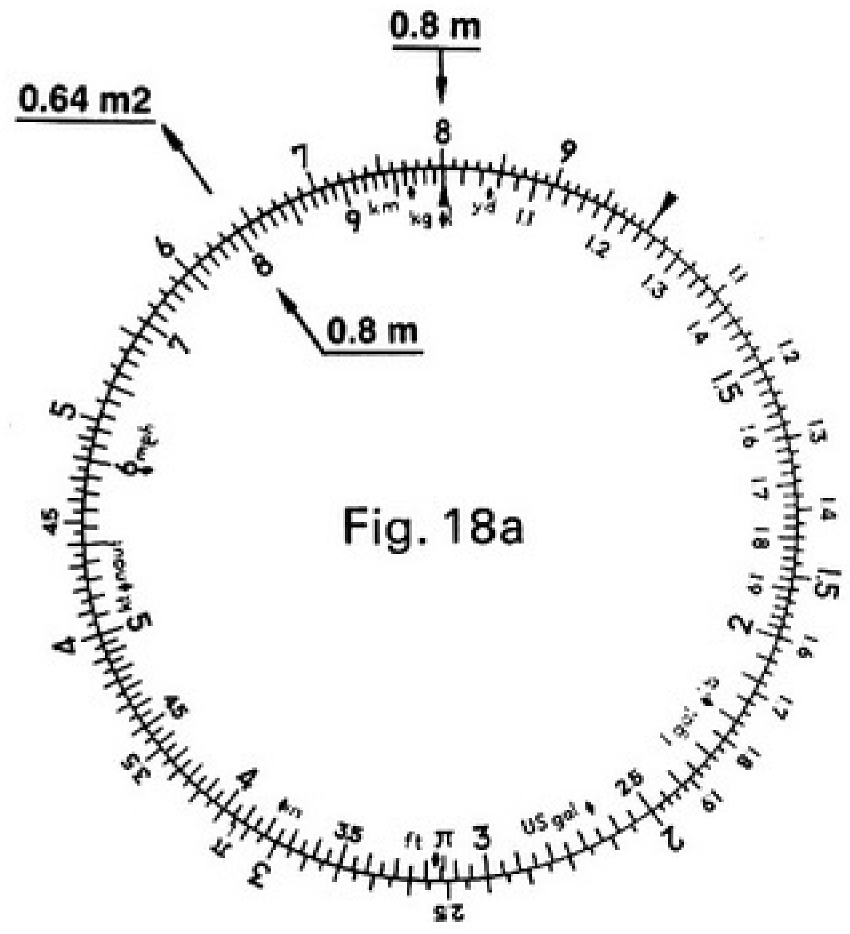


Fig. 18a

Examples of the conversion of different measurements (Fig. 19)

For lengths

Examples: 20 statute miles = ? km?
= ? nautical miles?

20 statute miles are equivalent to how many kilometres? Set the number 2 on the outer ring opposite to the number 6 (mi). The result, viz. 32.2 can be read off opposite to the 'km' dot.
With the same setting, 17.4 is indicated opposite the 'naut.' dot.
20 statute miles = 32.2 km = 17.4 nautical miles.

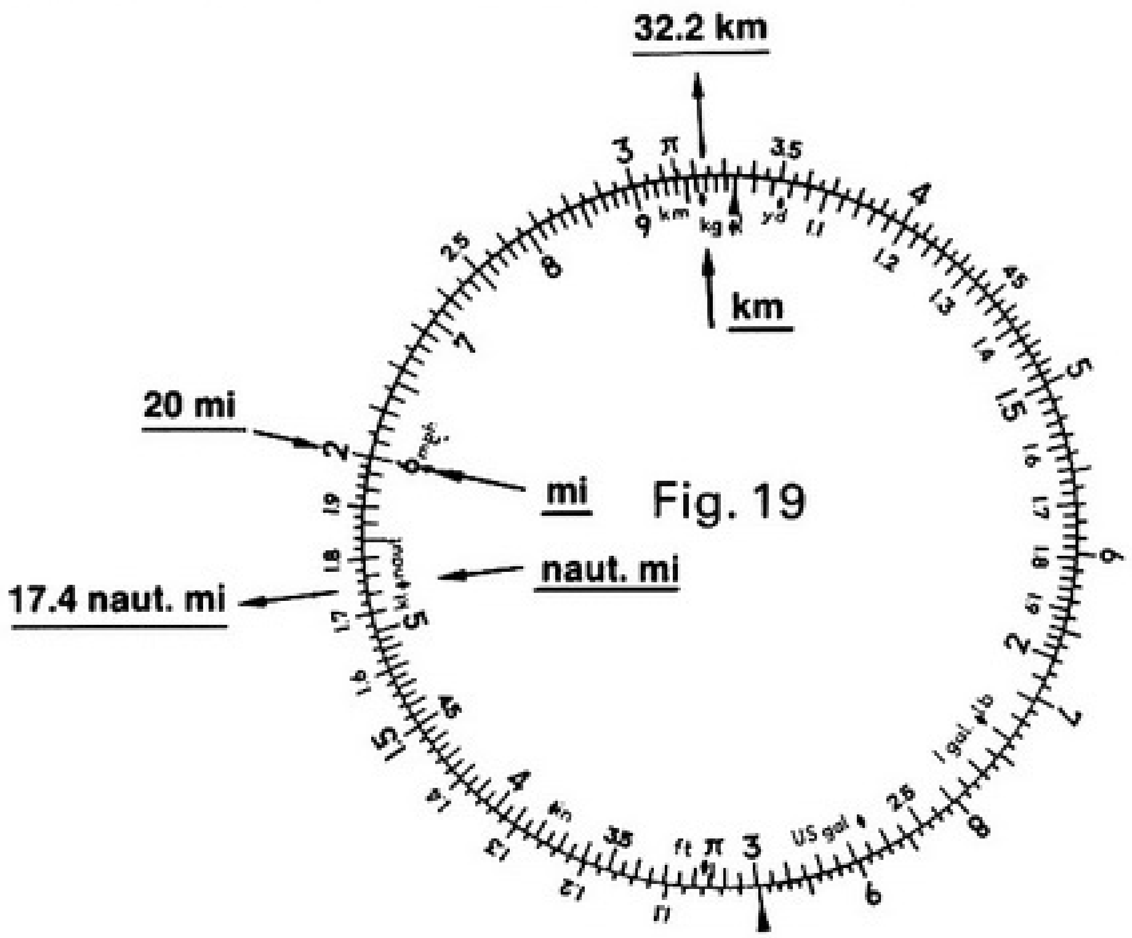


Fig. 19

(Fig. 20)

The height of a mountain is indicated as 1,800 m. How many feet is that? Set the number 1.8 opposite to the 'km' dot and read off the result on the outer ring, opposite to the 'ft' dot: 5,900 ft.

1,800 m = 5,900 ft.

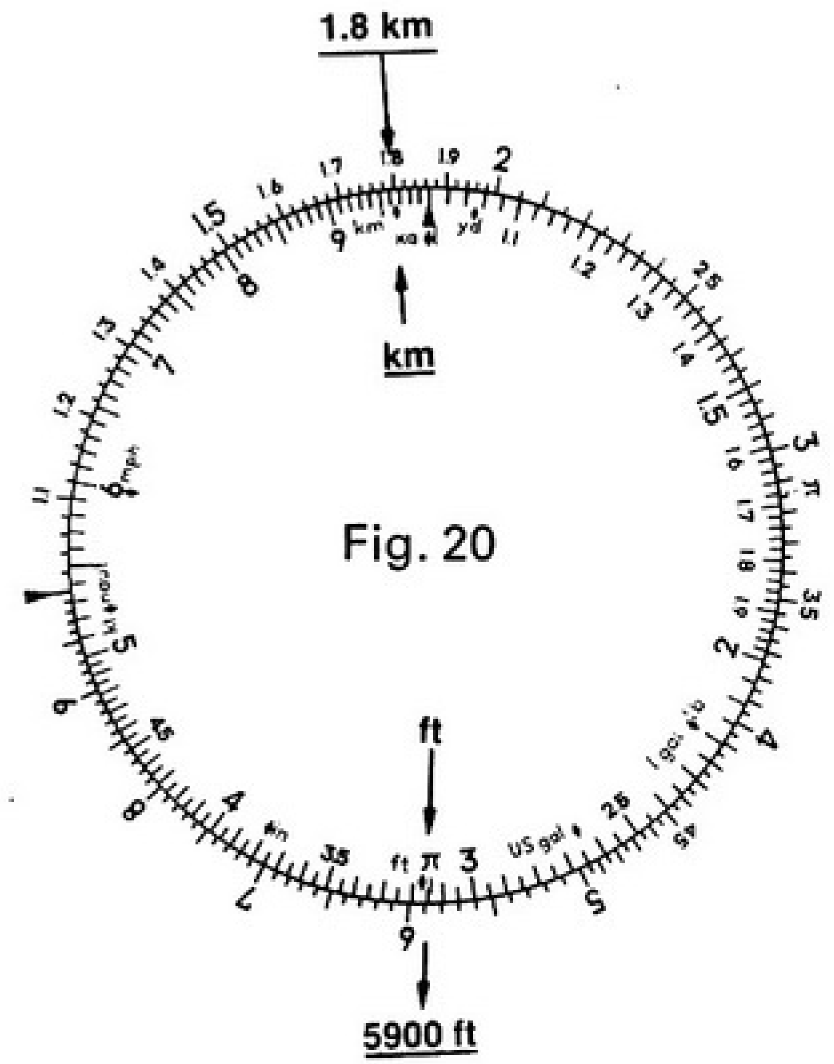


Fig. 20

(Fig. 21)

36 in = ? cm = ? yds?

36 inches are equivalent to how many cm? Find the number 3.6 on the outer ring and set it opposite to the 'in' dot.
The 'km' dot is opposite to the number 9.14, therefore 36 in = 91.4 cm.
The 'yd' dot is opposite to the mark ▼; it follows that 36 in = 91.4 cm = 1 yd = 3 ft.

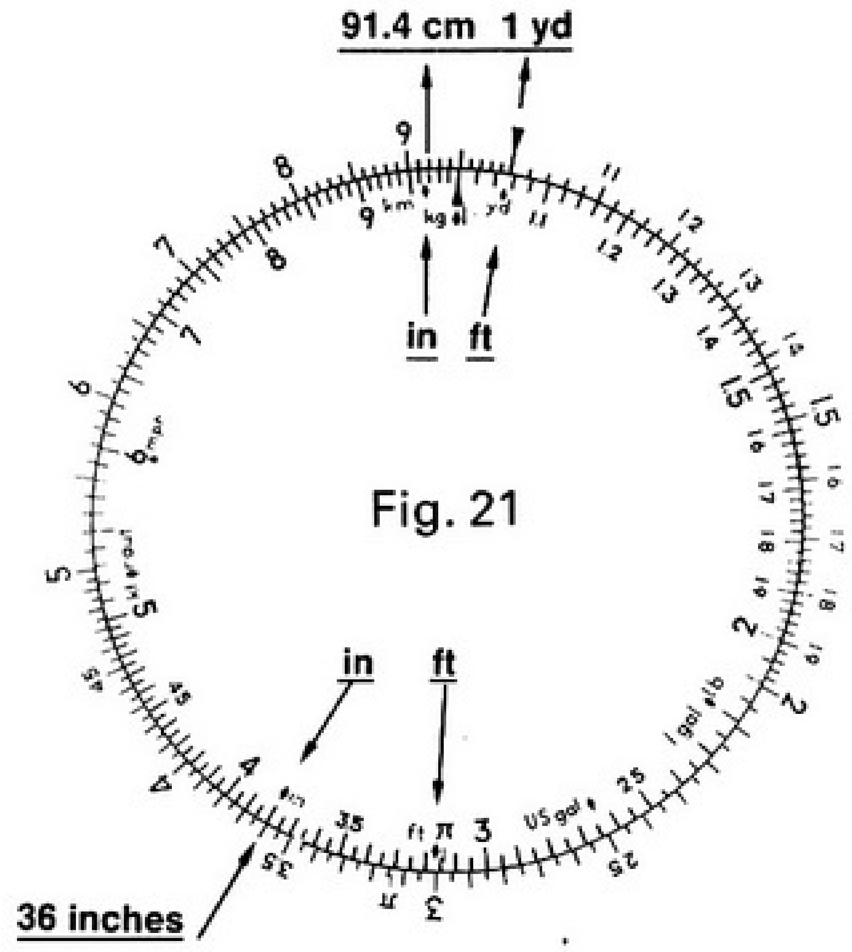


Fig. 21

For capacities (Fig. 22)

15 US gal = ? imp. gal?

Set the number 1.5 on the outer ring opposite to the 'US gal' dot. The outer ring indicates 5.6 above ▲ l (litre) and 1.25 opposite to 'I. gal'. Thus 15 US gal = 56 l = 12.5 imp. gal.

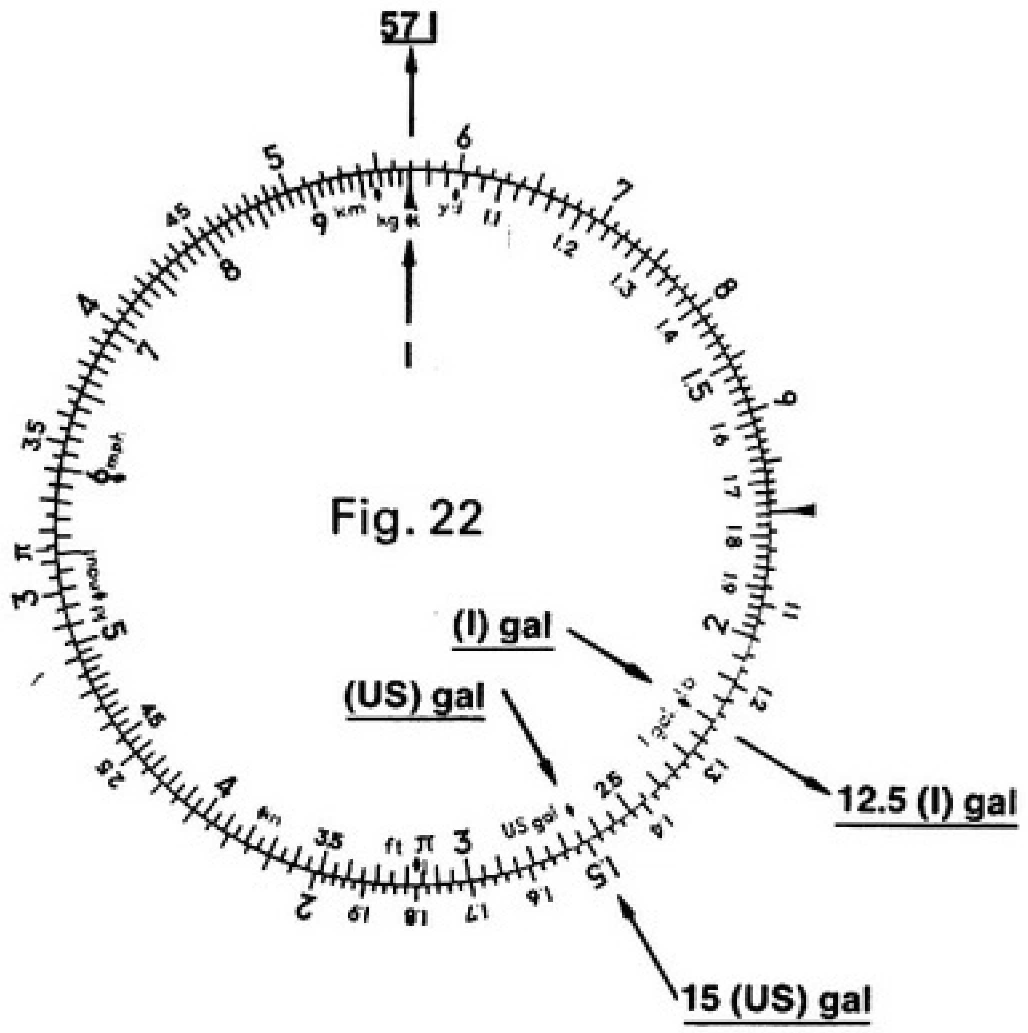


Fig. 22

For weights (Fig. 23)

50 lbs = ? kg?

Set the number 5 on the outer ring to the 'lb' dot. The result can be read off at the top: ▲ kg 2.27. Thus 50 lbs = 22.7 kg.

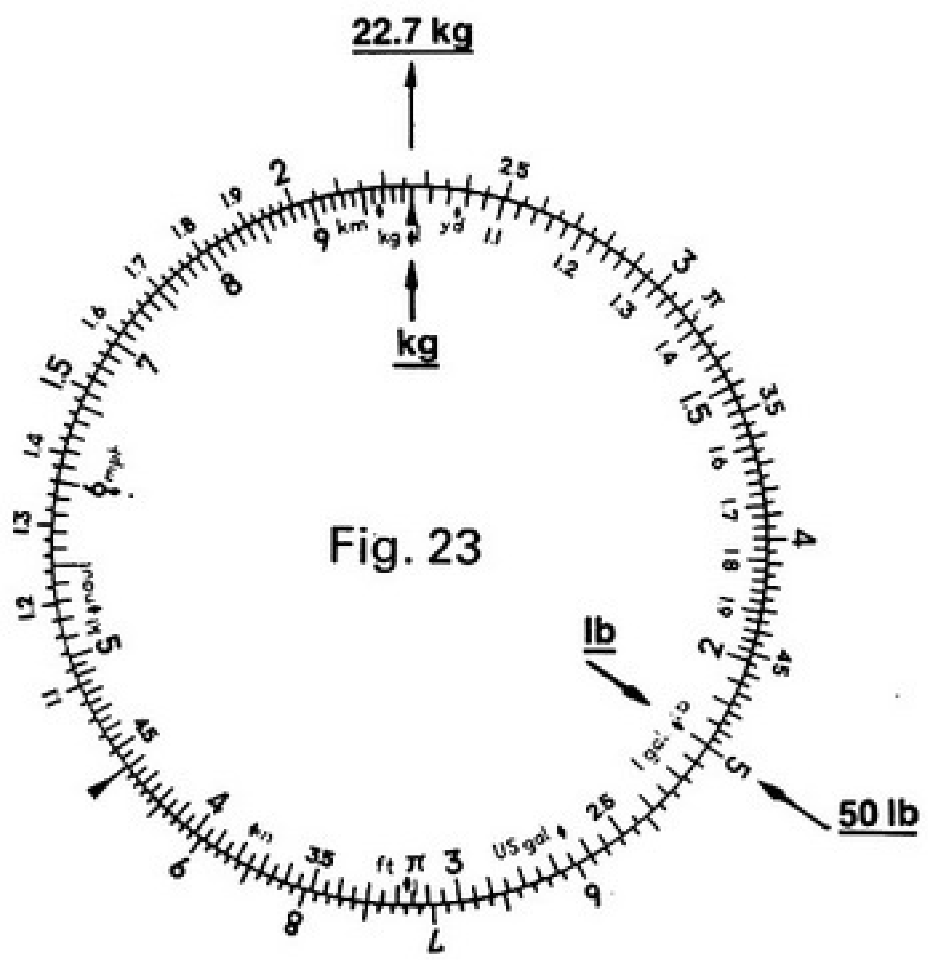


Fig. 23

Examples of speed conversions (Fig. 24)

135 km/h = ? km/min = ? km/s?

As 1 h = 60 min = 3,600 s, 135 km/h = $\frac{135\ \text{km}}{60\ \text{min}} = \frac{135\ \text{km}}{3{,}600\ \text{s}}$

Find the number 1.35 on the outer ring and set it opposite to the number 3.6 on the inner scale. 3.75 will be indicated above the mark ▲ and 2.25 opposite to the number 6. Therefore 135 km/h = 2.25 km/min = 37.5 m/s.

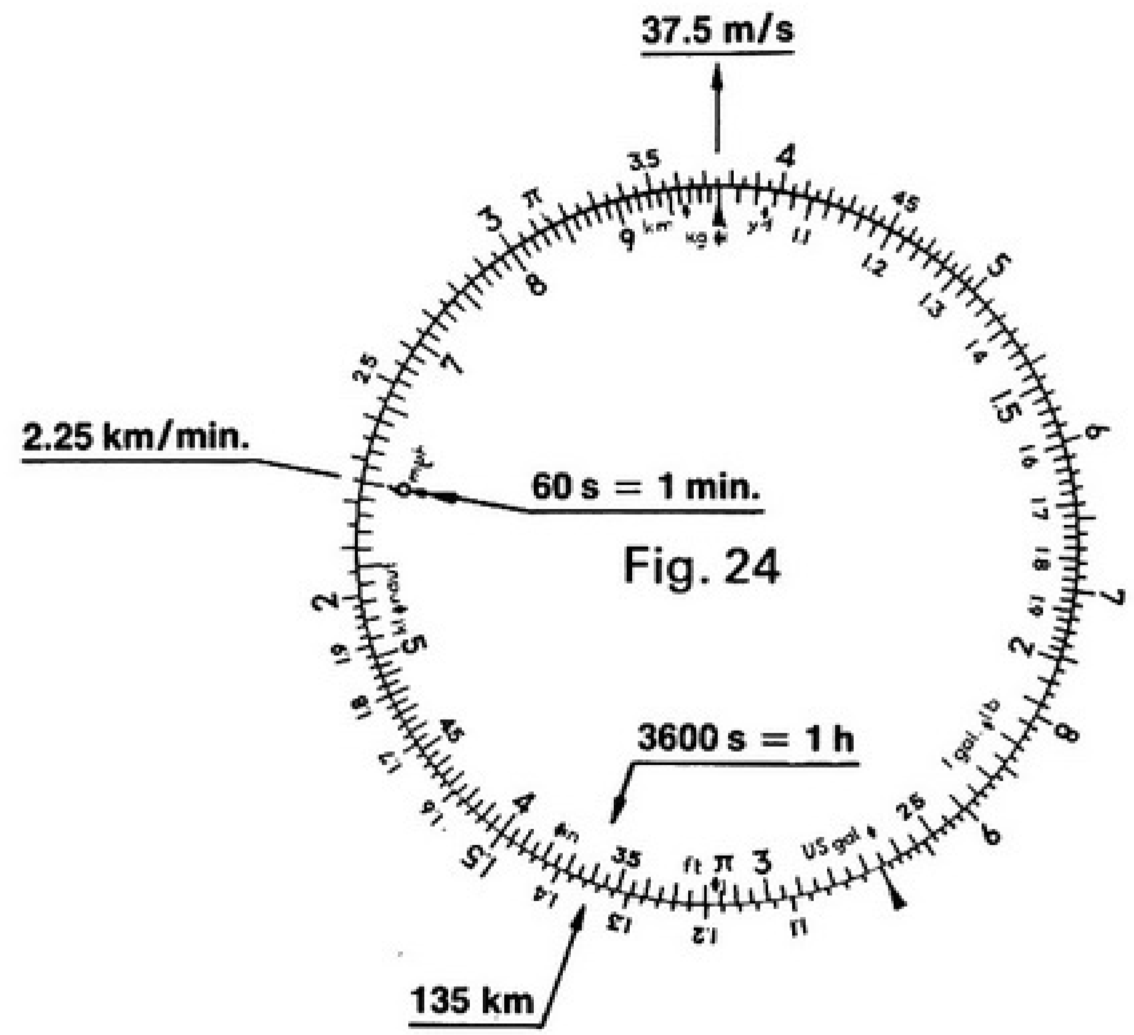


Fig. 24

(Fig. 25)
The speedometer of a car indicates 80 mph.
This makes how many miles per minute?
How many knots?
How many km/h?
Set the number 8 opposite to the number 6 (mph). 1.33 will be indicated at the top, opposite to the mark ▲, 6.92 opposite to the mark 'kn naut', and 1.29 opposite to the mark 'km'.
There 80 mph = 1.33 mile per minute = 69.2 knots = 129 km/h.

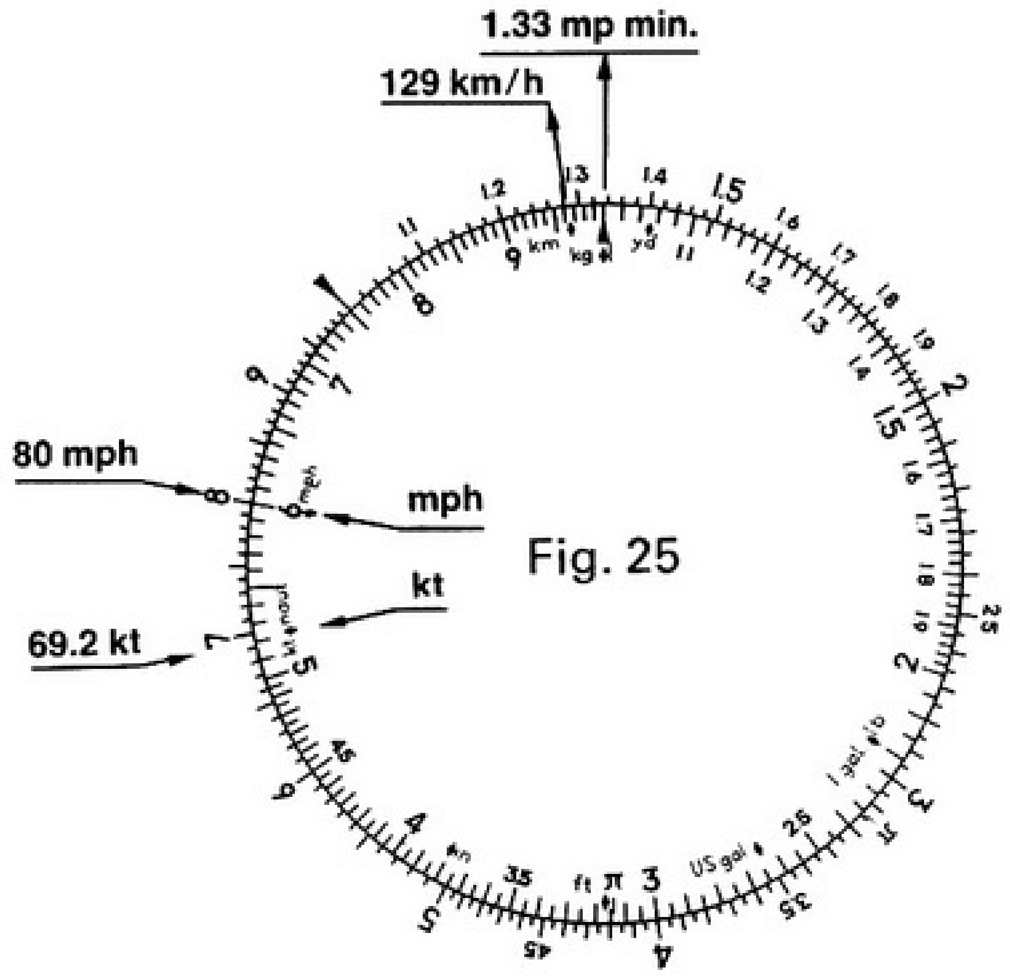


Fig. 25

(Fig. 26)
250 mph = ? km/h = ? knots?
Set the number 2.5 on the outer ring opposite to the number 6 (mph). 4.02 will be indicated on the outer ring opposite to the 'km' dot and 2.16 opposite to the 'kt' dot. Therefore 250 mph = 402 km/h = 216 knots.

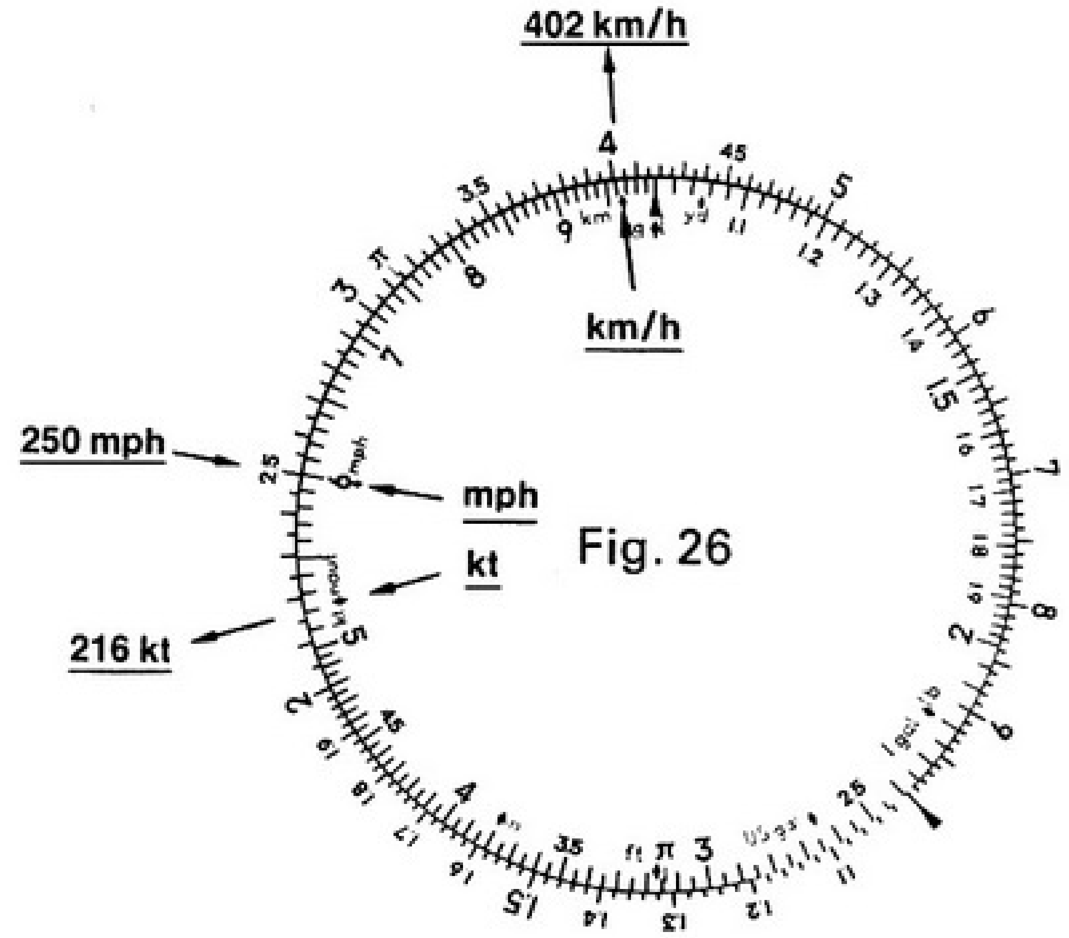


Fig. 26

(Fig. 27/27a)

The variometer of an aircraft shows a rate of climb of 3 m/s. What is the equivalent in m/min and in ft per min? Set the number 3 opposite to the mark ▲. 1.8 will be indicated opposite to the number 6. 3 m/s = 180 m/min. For conversion into ft per min, set the number 1.8 opposite to the mark 'km'. 5.9 will then be indicated under the mark 'ft'.
Therefore 3 m/s = 180 m/min = 590 ft per min.

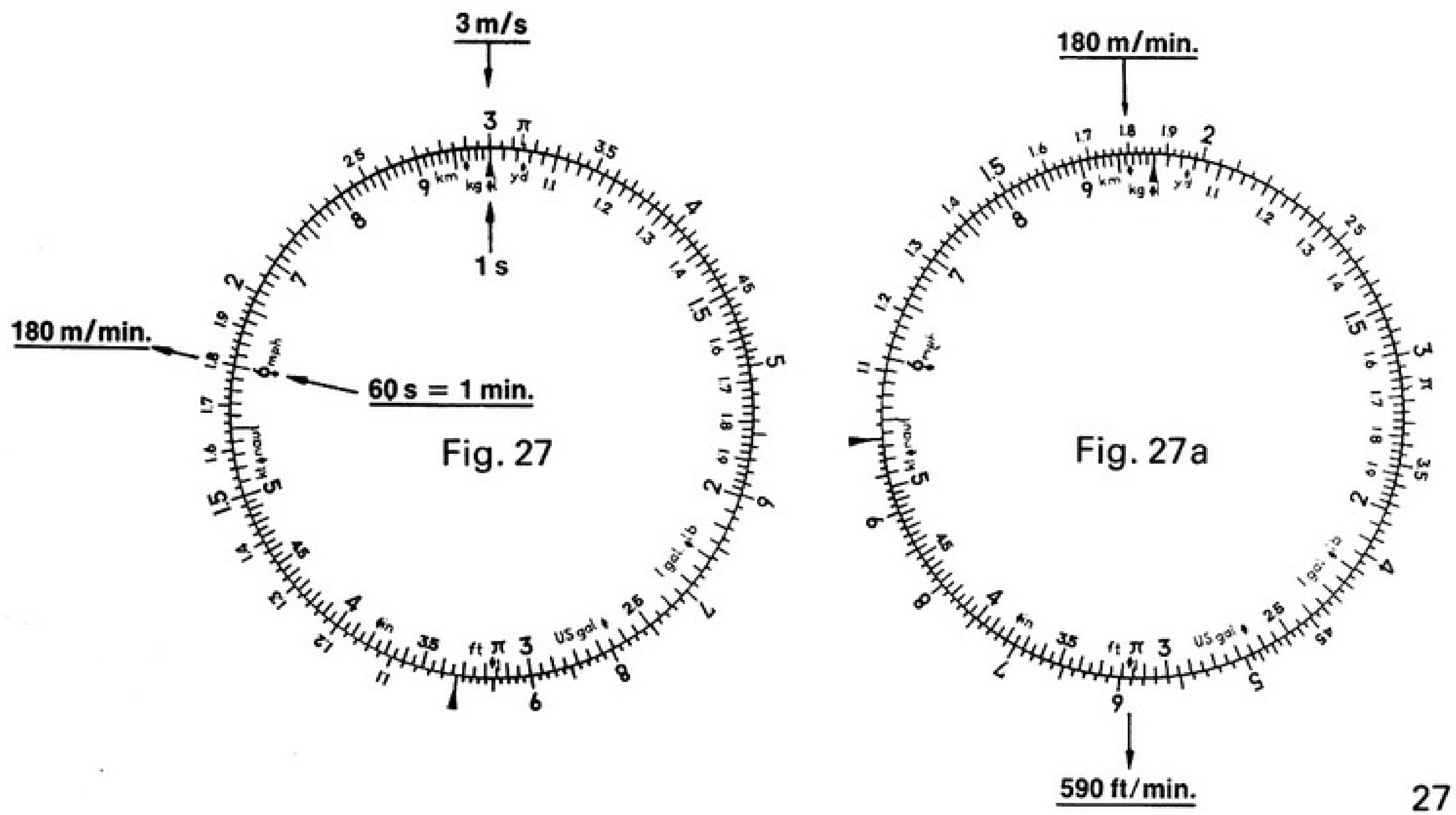


Fig. 27
Fig. 27a

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