

Nicola Marras

The “Easy E6-B” flight computer



Until the 70s on board the aircraft was only used the slide rule and today is still required: always work in any situation!



The slide rules, also known colloquially as “*slipsticks*”, were the only calculators available before the electronic age, traveled with the Apollo 11 on the moon and, essentials on board air-crafts like the firsts Jumbo Jets for the dead reckoning, are still required as a means of emergency.

The problems of navigation are always the same from immemorial time and a modern air-craft slide rule is not so different from the graphs drawn in the Middle Ages to determine the ship's position. The pilots have to find their location and perform various conversions of measures with great rapidity: in this task the slide rules are unbeatable. Mr. Spock used a slide rule on board Star Trek's Enterprise and nobody thought that its use was anachronistic in a highly technological future.

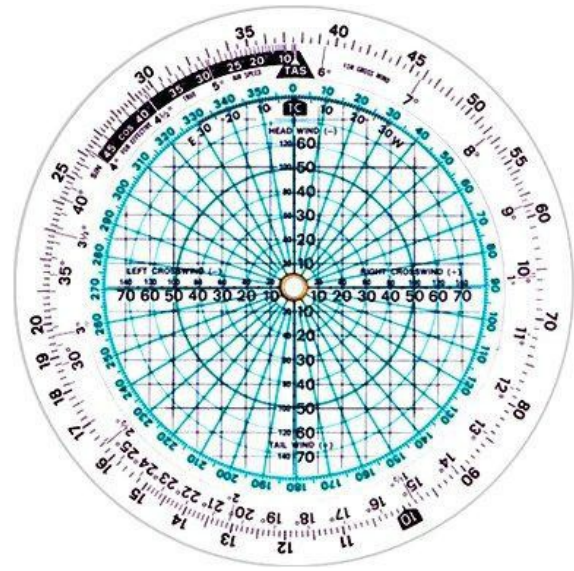
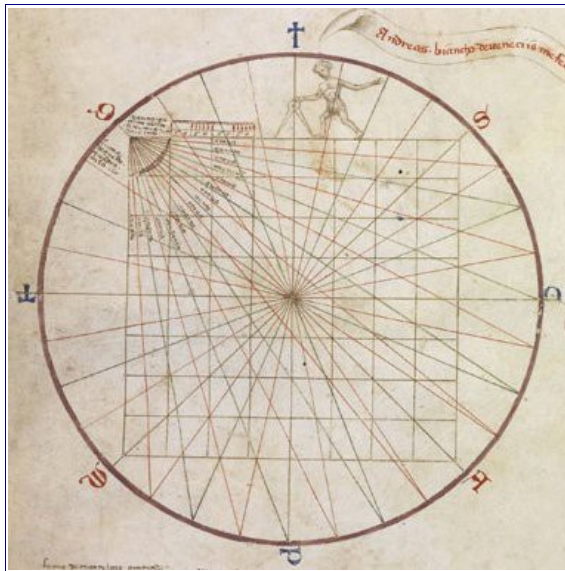


Chart of 1430 to determine the route and a modern aeronautical slide rule

The aircraft type, known as E6-B flight computer, was invented in the 30s and its use is so instinctive that it is often preferred to electronic calculators: solve all the problems of flight, find the angle of drift caused by the wind and it is essential to convert the jungle of measures in which the pilot must unravel. In the Air Force are used interchangeably meters, feet, nautical miles, statute miles, kilometers, liters, gallons, etc.

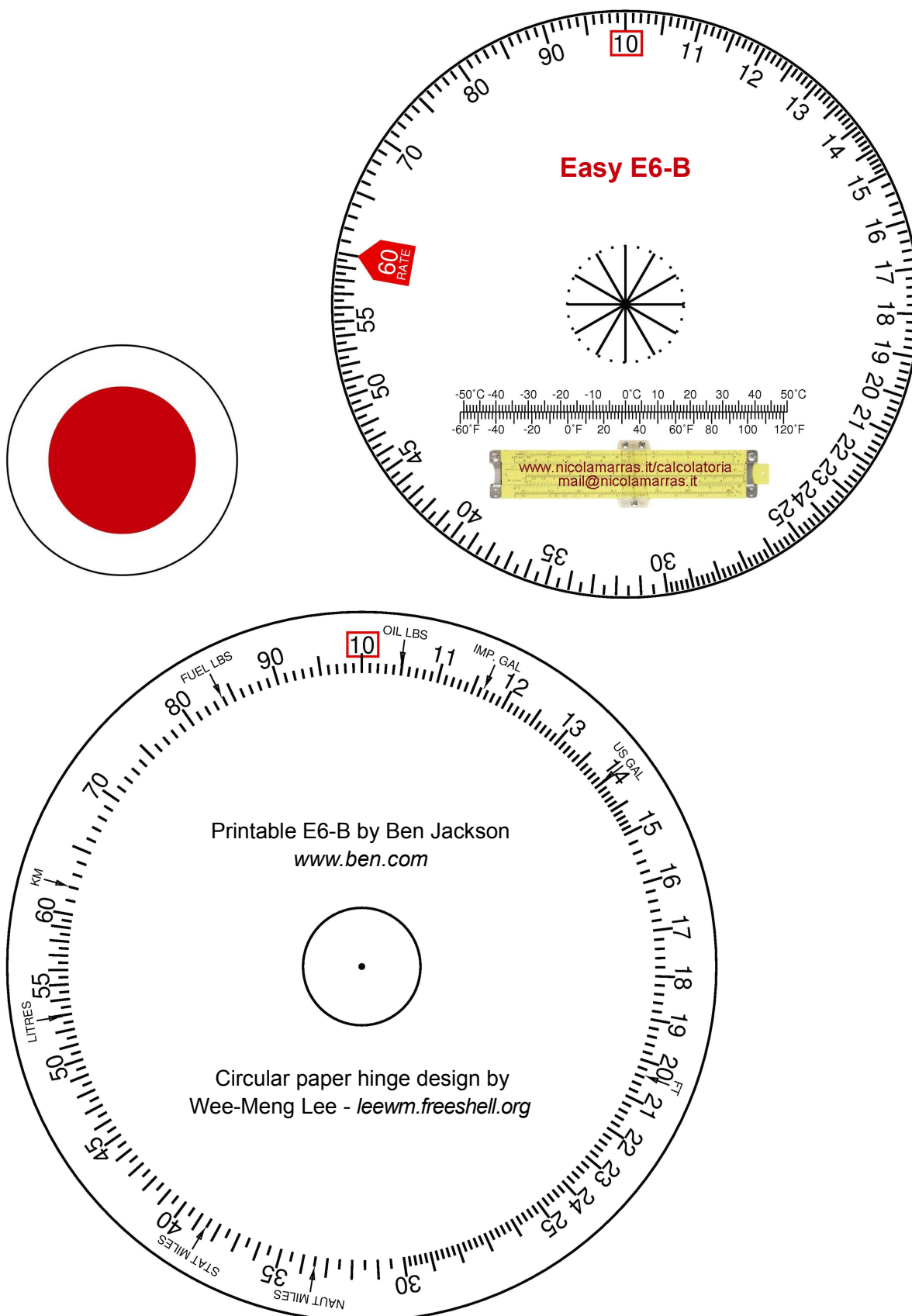
Since the 50s the E6-B, in a simplified form, has been included in the outer ring of watches especially designed for pilots. The most popular models are the Breitling's “Navitimer” and “Cosmonaute”, the last built for the NASA with the display divided in 24 hours as in space is impossible to distinguish day from night. It was the first watch to make an orbital flight, at the wrist of Scott Carpenter in Mercury-Atlas 7 mission of 1962, but it was not waterproof being soon replaced by the Omega Speedmaster. Although they lack of the graphic for the correction of the routes and of some specialized functions, such as determining the Mach number, are useful in solving problems of travel time, speed, fuel consumption and for make conversions between different units of measure or currency. In the next page we get a template to build a working model of the E6-B.



The 24 hours Breitling Cosmonaute and Scott Carpenter in a 1963 advertising

Easy E6-B

This is the reduced version of the aeronautical slide rule E6-B, useful in solving problems of time, speed, fuel consumption and for make conversions between different units of measure. To assembly cut along solid lines, fold along dotted lines and on inside disc fold stars flaps down. Then place discs together, push stars flaps of inside disc through center of outside disc, fold flaps all the way backwards and flatten. To make it perfect put a tiny drop of glue on each flap, position the small circle over flaps and press down. Remember to rotate the inner disc few times in case glue oozes out and glues the two discs together.





Nicola Marras

Was there life before computer?

The calculation before we went digital



Instructions

The Easy E-6B is a smaller version of the slide rule designed in the 30s and still supplied to aircraft. Although it lacks of the graphic for the correction of the routes and of some specialized functions, such as determining the Mach number, is useful in solving problems of travel time, speed, fuel consumption and for make conversions between different units of measure or currency. It is a real *"Flight Computer"*!

It has one mobile outer scale and a fixed inner one with the number 60 (*Speed index*) marked with an arrow; remember that, as in the standard slide rule, only the numbers are given: "0.9", "9", "90", "900", "9,000" are always read as "9" and how to locate the dot or how to add tenths or hundreds we must find by ourselves, but it is always instinctive to know if we are dealing with tens, hundreds or thousands.

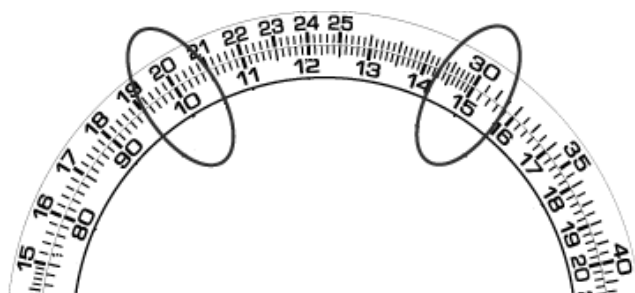
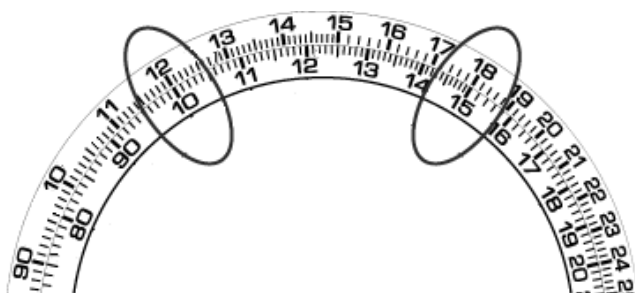
A. General Calculation Functions

1) Multiplication (bottom left)

Example: 12×15 .

Align 12 on the outer scale with 10 on the inner scale. Then 15 on the inner scale corresponds to 18 on the outer scale. Take into account the position of the decimal point and add one zero to obtain 180.

Remember always that with all slide rules the position of the decimal point cannot be obtained automatically.



2) Division (upper right)

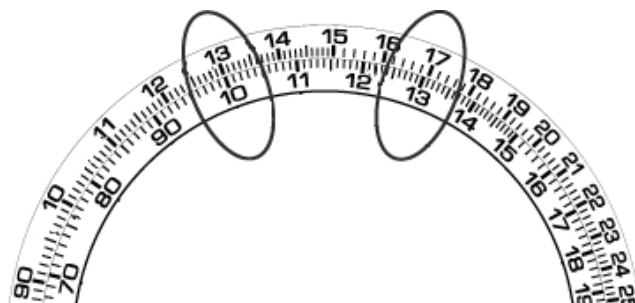
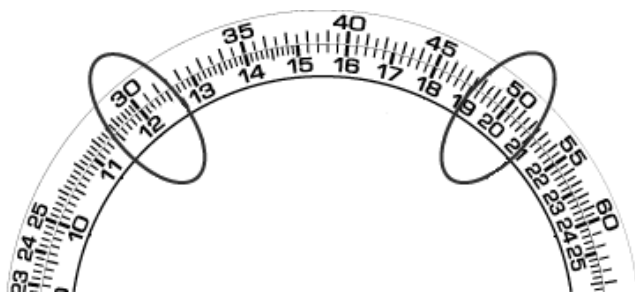
Example: $300/15$.

Align 30 on the outer scale with 15 on the inner scale. Then 10 on the inner scale corresponds to 20 on the outer scale. Take into account the position of the decimal point to obtain 20.

3) Reading Ratios (bottom left)

Example: $50/20=30/x$.

Align 50 on the outer scale with 20 on the inner scale. Then 30 on the outer scale corresponds to 12 on the inner scale. At this point the proportion for every value on the inner and outer scales is "50:20".



4) Square roots (upper right)

Example: Square root of 169.

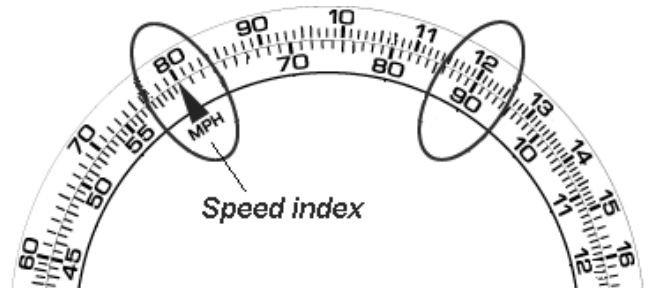
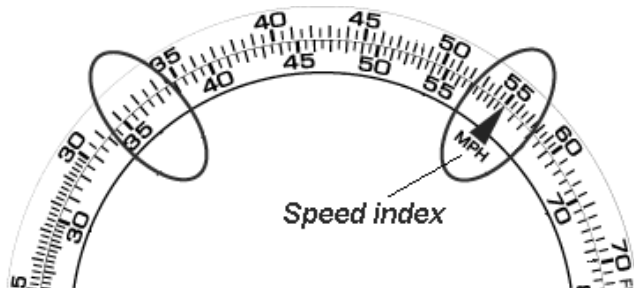
Turn the outer scale slowly and find a same value that corresponds to both 16.9 on the outer scale and 10 on the inner scale. In this example 16.9 on the outer scale corresponds to 13 on the inner scale and 10 on the inner scale corresponds to 13 on the outer scale. Thus the answer is 13.

B. Calculations for road use

1) Time required (bottom left)

Example: Obtain the time required for travel 330 kilometers driving at 55 km/h.

Align 55 on the outer scale with the *Speed index* (MPH). Then 33 on the outer scale corresponds to 36 on the inner scale. Thus the time required is 360 minutes (6 hours). Can also be calculated in miles instead of kilometers.



2) Average speed (upper right)

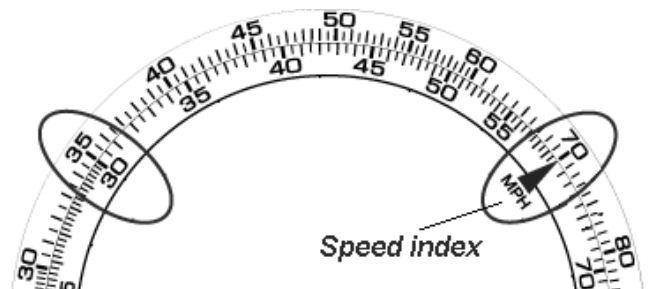
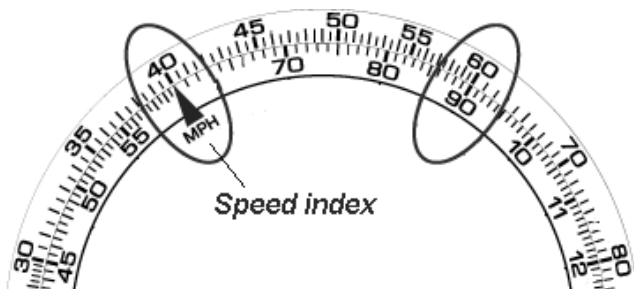
Example: obtain the average speed (km/h) needed to travel 120 kilometers in an hour and 30 minutes.

Align 12 on the outer scale with 90 (minutes) on the inner scale. Then the *Speed index* (MPH) corresponds to 80. Thus the average speed is 80 kilometers per hour.

3) Mileage (bottom left)

Example: obtain the mileage when the speed is 40 km/h and the running time is 1 hour and 30 minutes.

Align 40 on the outer scale with the *Speed index* (MPH). Then 90 (the minutes) on the inner scale corresponds to 60 on the outer scale. Thus the mileage is 60 kilometers.



4) Rate of fuel consumption (upper right)

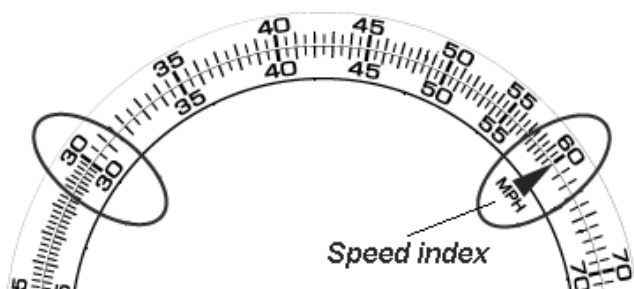
Example: obtain the rate of fuel consumption (liters/hour) when the running time is 5 hours and the total fuel consumption was 35 liters.

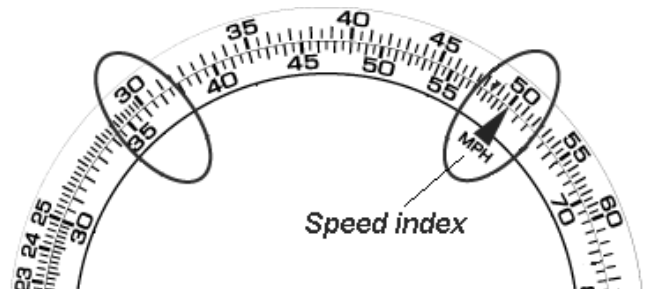
Align 35 on the outer scale with 30 on the inner scale (300 minutes = 5 hours). Then the *Speed index* (MPH) corresponds to 70. Thus the fuel consumption rate is 7 liters per hour.

5) Fuel required (bottom left)

Example: obtain the fuel required for a trip when the rate of fuel consumption is 6 liters per hour and the estimated running time is 5 hours.

Align 60 on the outer scale with the *Speed index* (MPH). Then 30 on the inner scale (300 minutes = 5 hours) corresponds to 30 on the outer scale. Thus the fuel required is 30 liters.





6) Estimated running time (upper right)

Example: obtain the estimated running time when the rate of fuel consumption is 5 liters per hour and the tank has 30 liters of fuel.

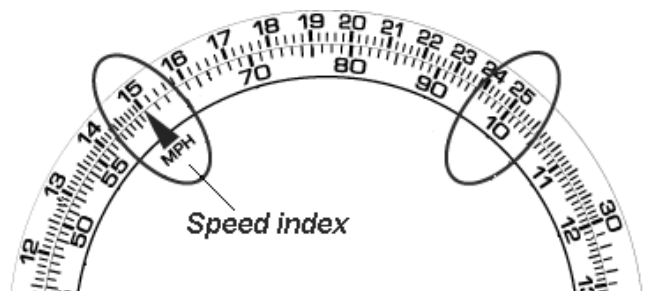
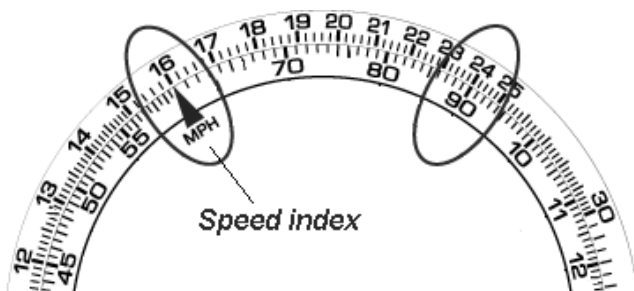
Align 50 on the outer scale with the *Speed index* (MPH). Then 30 on the outer scale corresponds to 360 on the inner scale. 360 minutes = 6 hours thus the estimated running time is 6 hours.

C. Calculations for aeronautic use

1) Time required (bottom left)

Example: obtain the time required to flight for 240 nautical miles at 160 knots.

Align 16 on the outer scale with the *Speed index* (MPH). Then 24 on the outer scale corresponds to 90 on the inner scale. Thus the time required for the flight is 1 hours and 30 minutes.



2) Average speed (upper right)

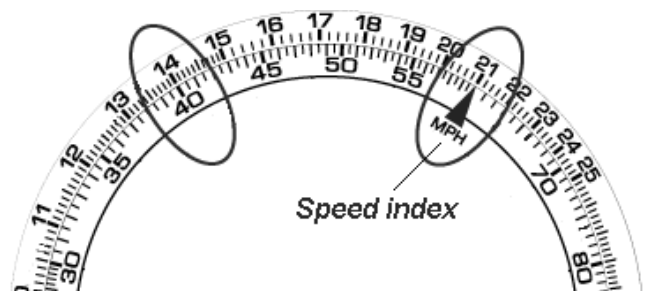
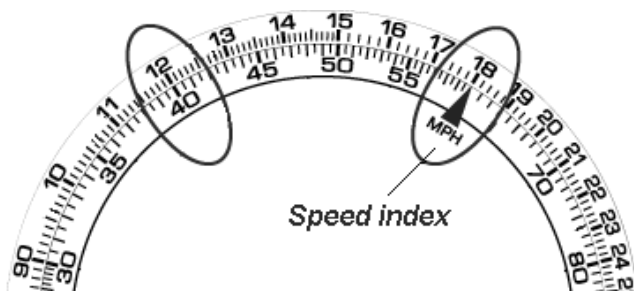
Example: obtain the average speed (air speed) needed to travel 250 nautical miles in an 1 hour and 40 minutes.

Align 25 on the outer scale with 100 (1 hours 40 minutes) on the inner scale. Then the *Speed index* (MPH) corresponds to 15. Thus the air speed for the flight is 150 knots.

3) Flight distance (bottom left)

Example: obtain the distance when the air speed is 180 knots and the flight time is 40 minutes.

Align 18 on the outer scale with the *Speed index* (MPH). Then 40 on the inner scale corresponds to 12 on the outer scale. Thus the air distance of the flight is 120 nautical miles.



4) Rate of fuel consumption (upper right)

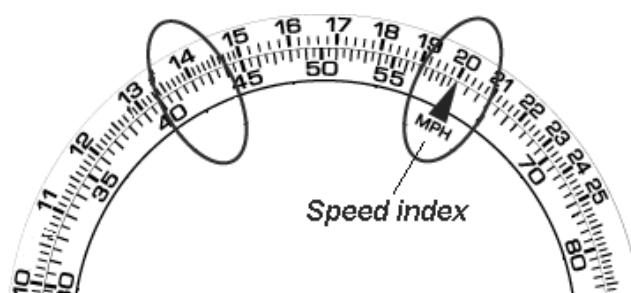
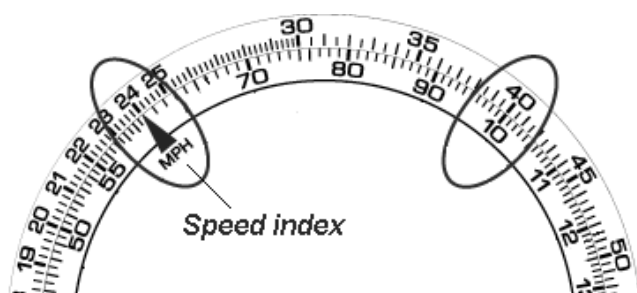
Example: obtain the rate of fuel consumption (gallons/hour) when the flight time is 40 minutes and the fuel consumption is 140 gallons.

Align 14 on the outer scale with 40 on the inner scale. Then the *Speed index* (MPH) corresponds to 21. Thus the rate of fuel consumption is 210 gallons per hour.

5) Fuel required (bottom left)

Example: obtain the fuel required for a flight when the rate of fuel consumption is 240 gallons per hour and the flight time is 1 hours and 40 minutes.

Align 24 on the outer scale with the *Speed index* (MPH). Then 100 (1 hour 40 minutes) on the inner scale corresponds to 40 on the outer scale. Thus the fuel required is 400 gallons.



6) Estimated flight time (upper right)

Example: obtain the estimated flight time when the rate of fuel consumption is 200 gallons per hour and the aircraft has 1,400 gallons of fuel.

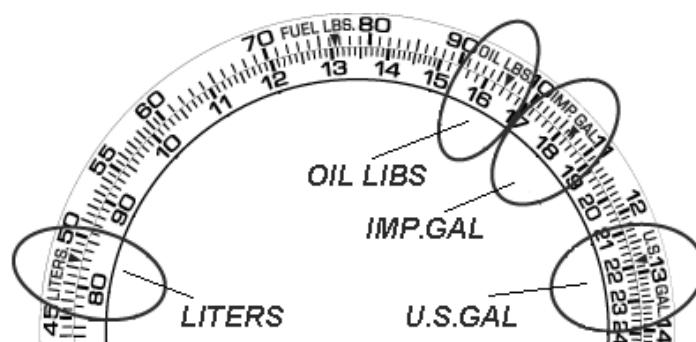
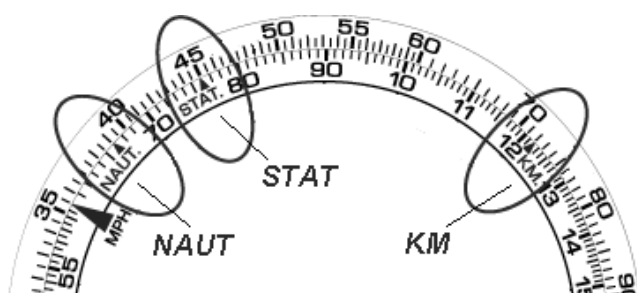
Align 20 on the outer scale with the *Speed index* (MPH). Then 14 on the outer scale corresponds to 42 on the inner scale. Thus the estimated flight time is 420 minutes (7 hours).

D. Conversions

1) Distance (bottom left)

Example: convert 45 miles into nautical miles and kilometers.

Align 45 with *STAT*. Then *NAUT* corresponds to about 39 nautical miles and *KM* to about 72 km.



2) Weight (upper right)

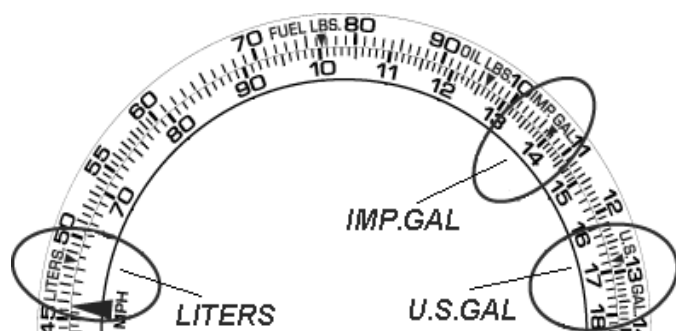
Example: convert 16.4 oil lbs. into U.S. Gallons, IMP. gallons and liters.

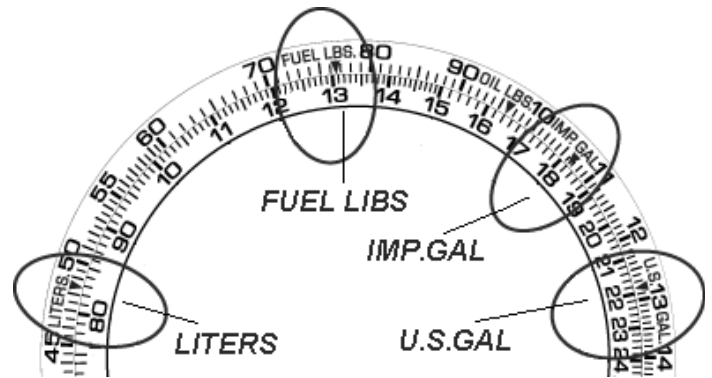
Align 16.4 on the inner scale with *OIL LBS* on the outer scale. Then *U.S. GAL* corresponds to about 2.2 on the inner scale, *IMP. GAL* to about 1.8 and *LITERS* to about 8.3.

3) Volume (bottom left)

Example: Convert 16.8 U.S. gallons into and IMP. gallons and liters.

Align 16.8 on the inner scale with *U.S. GAL* on the outer scale. Then *IMP. GAL* corresponds to about 14 on the inner scale and *LITERS* to about 63.5.





4) Weight to volume (upper right)

Example: Convert 13.1 fuel lbs. into U.S. Gallons, IMP. gallons and liters.

Align 13.1 on the inner scale with *FUEL LBS* on the outer scale. Then *U.S. GAL* corresponds to about 2.2 on the inner scale, *IMP. GAL* to about 1.8 and *LITERS* to about 8.3.

You can also make currency conversions, suppose the conversions rate for Euro is € 1.60 to \$1.00: rotate the outer scale to match 16 over 10, the outer scale becomes Euro and the middle scale becomes US Dollars. You can leave the scales like that until the exchange rate changes. If you want to convert € 4.00 to Dollars look at the number in the middle scale opposite the 40 on the outer scale. The number is 25. You can deduct that € 4.00 are \$2.50. For other useful conversions follow this table.

	Match these numbers opposite to the 10 of the inner scale:	Outer scale represent	Inside scale represent
Centimeter / Inches	2.54	Centimeters	Inches
Feet / Meters	3.28	Feet	Meters
Yards / Meters	1.09	Yards	Meters
Kilometers / Miles	1.61	Kilometers	Miles
Acres / Hectares	2.47	Acres	Hectares
Grams / Ounces	28.35	Grams	Ounces
Pounds / Kilograms	2.21	Pounds	Kilograms
Kilogram / US Tons	907.00	Kilograms	US Tons

New Navigation Computer Solves Flight Problems

SIMPLIFYING aerial navigation problems to a point never before possible, an entirely new type navigation computer has been perfected by engineers and adopted as standard equipment by many pilots on the nation-wide air travel systems.

Designed to provide an immediate answer to navigation questions the pilot must face during the course of a flight, the new instrument combines features of a slide rule with a series of special scales in the form of three celluloid discs which rotate around a common center.

By means of this instrument the pilot may determine immediately the true air speed of the plane, the compass course which he must follow, gasoline consumption and the flying time between terminals. It can also be used to calculate wind direction and velocity while the plane is in flight, allowing the pilot to keep an accurate check of upper air information provided at the beginning of the flight.



New type navigation computer in use during flight. With this instrument the pilot may quickly determine answers to flight problems arising during the course of the trip.

The presentation of the E6-B in the 30s

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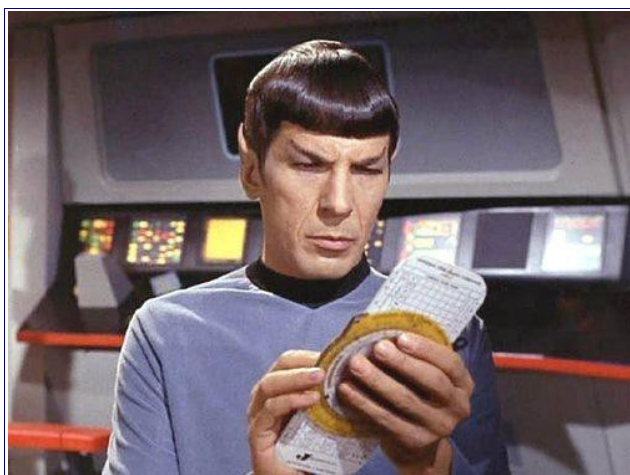
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The slide rules, used on the Apollo 11 (and on Star Trek's Enterprise), are still required on the airplanes: how else could we find the way back home in case of electronic failure?



Nicola Marras - Italy. Collector, member of ARC and of the Oughtred Society, promotes through exhibits and educational courses the memory of old calculating devices and ancient navigation systems. Nicola wants young people to understand that the world as we see it now, skyscrapers, highways, atomic power, space exploration and the electronic computer, was only possible because of simple tools like slide rules.

His main event every year is the exhibit at Cagliari Festivalscienza. His goal is the construction of a permanent museum of calculus. Nicola Marras' website, both in Italian and English, is: www.nicolamarras.it/calcolatoria. *Source: International Slide Rule Museum Who's Who.*