Gauging: the art behind the slide rule

Tom Martin

‘The village master taught his little school
The village all declared how much he knew,
'Twas certain he could write, and cipher too;
Lands he could measure, times and tides presage,
And e'en the story ran that he could gauge;’

Oliver Goldsmith (1730 - 1774)
The Deserted Village.

As Goldsmith infers, the gauger's art always seems to have had an air of mystery and a perceived knowledge of mathematics above that of the ordinary man.

The initiative for this paper arose from UKSRC members' interest in a late 19th Century picture of gaugers at work in the London Docks (Fig. 2), published in the Autumn 2001 *Slide Rule Gazette*[1] and subsequently the Spring 2002 issue of the *Journal of the Oughtred Society*.[2]

Although the author spent his career in the UK brewing industry, it is not written from any particular expertise in gauging or Customs and Excise operations.

Historically, gauging has included measuring the volume of anything from a bottle or brick to a whole ship but the purpose here is to describe and discuss some of the gauging instruments and calculations used by UK Customs and Excise and manufacturers for determining the volume and contents of liquid containers. Peter Hopp has given, already, an extensive survey of alcohol slide rules at the 1999 Cambridge International Meeting[3] and this also contains references to articles on the use of these rules in gauging.

In gauging it is important to understand the definition of three established terms:-

Content - This is the volumetric capacity of a container, not the volume of its contents.
Ullage - The strict dictionary definition of ullage is the vacuity or empty part of a container. In gauging it has become more generally the volume of liquid but the terms ‘wet’ and ‘dry ullage are also used.
Dip - This is the depth, or height from any set point. In a cask the ‘dry dip’ is the distance from the base of the bung hole to the surface of the liquid and the ‘wet dip’ is the distance from the bottom of the cask to the liquid surface.

Customs, the collection of duty on imported goods has a very long history (Chaucer was a Customs Officer as were his father and grandfather) but the excise, a tax on home goods in manufacture, or for retail consumption, is relatively recent.

Although there were strongly resisted attempts to introduce excise in the 1500s it was finally introduced in 1643, with the aim of maintaining the forces raised by Parliament. Excise was initially a duty on home produced alcoholic beverages and soap but, being easily applied, spread rapidly to a wide range of goods including imports. The government departments of Customs and Excise merged only in 1909 and any instruments or slide rules with a C&E mark should be dated after then. A recent and very readable account of the history of Customs and Excise is given in *Something to Declare* by Graham Smith, a past librarian and archivist to H.M. Customs and Excise.[4] This book, incidentally, uses part of the Gaugers picture on its dust jacket.

The explosion of excise duties in the second half of the 17th century led to much corruption and the need to employ and train much better educated excise officers. In 1683 Thomas Everard who had risen from Officer to Excise Commissioner produced both his book on gauging, which went through many editions, and his gauger's slide rule which, in modified form was used for gauging calculations well into the 20th century.

Beer	1643 - 1830, 1880 -
Bricks	1750 - 1850
Candles	1710 - 1832
Cider	1643 - 1830,
	1916 - 1923
	1976 -
Glass	1695 - 1845
Hops	1711 - 1862
Malt	1697 - 1880
Paper	1712 - 1861
Salt	1643 - 60
	1712 - 1853
Soap	1643 - 60
	1712 - 1853
Spirits	1643 -
Starch	1713 - 1853
Sugar	1837 - 74
	1915 - 1962
British wines	1696 - 1834
	1927
Verjuice	? - 1818
Vinegar	1643 - 1844

Table 1. Some goods historically subject to Excise Duty and Gauging

Table 1 gives a non-exhaustive list illustrating goods that have been subject to excise duty and requiring gauging at some time since 1643.

Gauging rules often show evidence of these goods through calculation factors marked on the slide rule as 'gauge points', or through values written on the back of the slide. Table 2 from the *Practical Gager* of 1803[5] lists commonly used factors at that time. These are based on the ‘Winchester’ measure prior

Multipliers, Divisors, and Gage Points, for Squares and Circles

	Factors for		Divisors for		Gage Points for	
	Squares	Circles	Squares	Circles	Squares	Circles
Inches in the area of unity	1	,785398	1	1.27324	1	1.128
A superficial foot	,006944	,005454	144.	183.34	12.	13.54
A solid foot	,000578	,000454	1728	2200.16	41.57	46.91
Ale gallon	,003546	,002785	282.	359.05	16.79	18.95
Wine gallon	,004329	,003399	231.	294.12	15.19	17.15
Malt or corn bushel	,000465	,000365	2150.42	2738.00	46.37	52.32
Malt gallon	,003720	,002922	268.8	342.24	16.39	18.5
Mash tun gallon	,004405	,00346	227	289	15.1	17.07
A pound of hard soap cold	,036845	,028939	27.14	34.56	5.21	5.88
A pound of hot soap	,035714	,028050	28.0	35.65	5.29	5.97
A pound of green soap	,038956	,0306	25.67	32.68	5.06	5.72
A pound of white soft soap	,039123	,030731	25.56	32.54	5.05	5.7
A pound of tallow net	,031844	,025101	31.4	39.98	5.6	6.32
A pound of green starch	,028736	,022565	34.8	44.32	5.9	6.66
A pound of dry starch	,024813	,019491	40.3	51.3	6.35	7.16
A pound of flint glass	,094697	,074405	10.56	13.4	3.25	3.69
A pound of white glass	,071123	,05586	14.06	17.9	3.74	4.32
A pound of green glass	,082102	,064516	12.18	15.5	3.48	3.94

*Table 2. Table of Factors (*The Practical Gager*, 1803).*

to the adoption of the Imperial measurement system in 1824 and can aid the dating of old gauging rules.

The growth of the Excise and the number of officers employed to monitor the many local producers spawned a range of books on the mathematics of gauging, often written by senior excise officers. An indicative list of these books is given by Peter Hopp in his paper on 'Alcohol Slide Rules'.[3] Many of these books, however, are more concerned with gauging calculations and information on measurement equipment and technique is relatively weak. Much clearer information comes from H.M. Customs and Excise internal publications for officers. As a result of changes in technology and duty collection systems, however, Customs and Excise Gauging Instructions for Officers were published last in 1968 and are no longer extant.

Initially gauging measurements were probably by basic rulers, tapes, dipping sticks and simple callipers, but over the years more specialised equipment was developed, some aimed primarily at prevention of fraud.

Authors considered that gauging of casks was the most difficult part of the art of gauging, principally due to the very wide range of sizes and shapes available. Originally casks were separated into four varieties according to their curvature as demonstrated in Fig. 1, taken from *Gauging and Operations in Bond* 1885.[6] Geometrically and for mathematical treatment these have been described as;

First Variety - the middle frustrum of a spheroid

Second Variety - the middle frustrum of a parabolic spindle

Third Variety - two equal frustrums of a paraboloid joined at the base

Fourth Variety - two equal frustrums of a cone joined at the base

Although the existence of these four cask types had long been recognised and their mathematical treatment expounded in text-books, for practical purposes most casks were treated as being of the first variety. Crouch[7] in 1723 notes that ' … in the Practice of the Customs and Excise at the Waterside in the Port of London, as most casks may be justly comprehended under the first variety …'

All cask gauging involved determining accurately three measurements:

1. The internal diameter at the bung hole i.e. the bilge or centre of the cask.
2. The internal diameter at the head, or end of the cask.
3. The internal length.

These were taken, normally, with the casks lying on their sides, bung uppermost, but techniques were also available for casks standing on their ends. Whatever the variety of cask, these measurements were used to approximate the curved shape of a cask to that of an equivalent regular cylinder and hence calculate the volume.

From the beginning, gauger's slide rules included scales for determining the mean

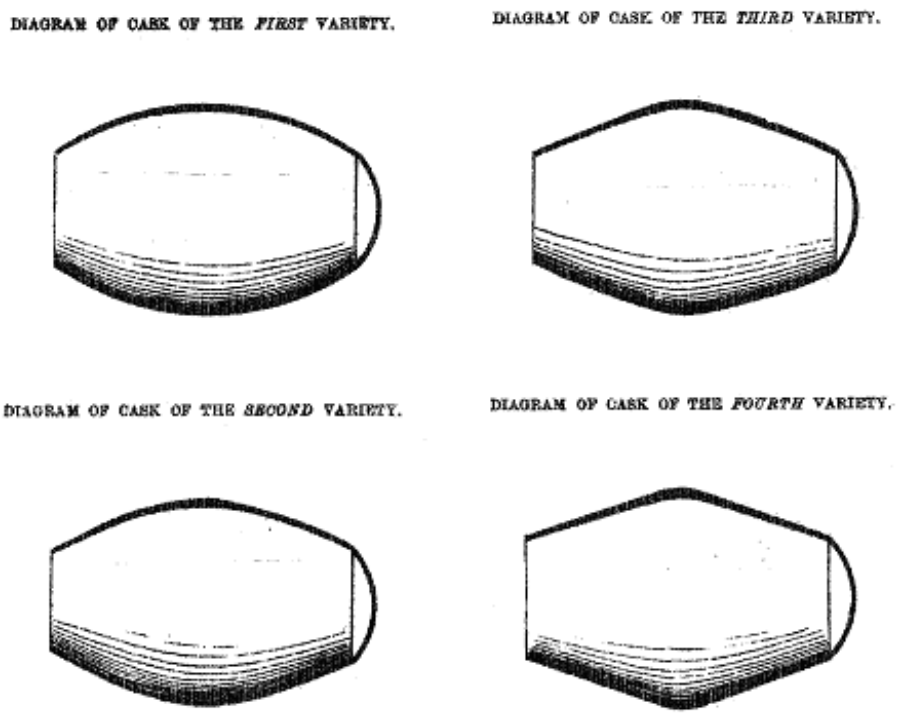

Figure 1. The four varieties of cask (from Gauging and Operations in Bond*, 1885)*

diameter of a cask from the difference between the end and bung diameters. These were on the side in an Everard type 2-slide rule, but on later 4-slide types could be found on the reverse of a slide. Examples and the development of these rules have been described by Barnes[8] and Hopp.[3]

Operations at the Port of London Authority were long accepted as defining the standard to which other ports and Customs and Excise activities should operate. In a complex hierarchy of Surveyors, Searchers, Landing and Coast Waiters, Accountants, Lockers, Gatekeepers, Tide Surveyors, Weighers etc., Gaugers were defined as those responsible for assessing liquid measures.

Leadbetter, in 1760,[9] makes special mention of cask gauging as practiced at the waterside in the Port of London. He notes especially the use of callipers to measure the length of the cask and the

Figure 2. Gaugers at work (for explanation of annotations see text)

use of head and bung rods for measuring the diameters at the ends and bungs of the cask. He gives no description of these rods but notes that they are made by Mr John Gilbert, Mathematical Instrument Maker to the Custom House in London and the Out-Ports.

The activities of the port gaugers had become strictly regulated by the early 19th century as illustrated by extracts from official instructions to Customs gaugers in 1826 in Appendix 1. The equipment already in established use then, appears to change very little over the next 150 years. The diversity of the work is illustrated by a supplement to the instructions which lists over 60 different casks requiring special consideration and containing anything from the usual wines and spirits to lime juice and whale oil.

Dock practice at that time is described by Jonas.[10] As soon as casks were landed they were gauged by an excise officer. A customs officer then repeated the measurements and his statement was revised by an officer called a Jerquer. Any disputes were resolved by senior officers and finally the consignment was examined by the merchant's own gauger.

The gauger's tools

A booklet produced by Joseph Long, the slide rule and instrument manufacturer, in 1895 - *Description and Use of the Sliding Rule ... also directions for Cask and Malt Gauging etc* …[11] - is contemporary with the photograph of dock gaugers (Fig. 2) and again, has a specific section 'The method of Gauging by Callipers, as Practiced at the Port of London, etc.'

Long's booklet states - The instruments requisite for this purpose are -

1. A pair of callipers, for taking the length of the cask (A in photo).
2. A pair of cross callipers for taking the diameter at the bung, externally (B in photo).
3. A bung rod for taking the diameter internally (C in photo).
4. A head rod for taking the diameters of each head and computing the contents and ullages (D in photo).

Other elements in the photo include:

E. Tin velincher or sample thief for sampling cask contents.

F. Sample jar, probably for taking liquid strength by hydrometer.

G. Wicker basket containing sealed samples for analysis or reference.

H. Chalked gauger's measurements on head of cask for calculating contents.

I. Cask bungs wrapped in hessian a) to give watertight seal, b) for ease of removal.

(Note that the head gear in this staged photograph probably indicates the port hierarchy flat cap, sampler; peaked cap, gauger; bowler, foreman; top hat, surveyor).

Although routine cask gauging operations were carried out using callipers, head and bung rods they could be supplemented with other equipment when

required. The head and bung rods also evolved as multifunctional instruments and the use and properties of all these gauger's tools as developed in the 20th century will be described. These descriptions are limited to that required for understanding use of the equipment rather than the extensive procedural details of the latter day Customs and Excise Manuals.

The Bung Rod - This is usually 48 inches long and half an inch square. It is marked on two opposite sides in inches and tenths of inches. The other two sides are marked in 'diagonal' and 'imperial area' lines (see Fig. 4a).

The Inch Line - The rod has a sliding brass flange held in place by two springs that extend 1inch below the plate notched at half and three-quarters of an inch.

When inserted vertically to measure the internal diameter of the cask, the flange is lowered to the bunghole and the notched springs allow determination of the inside depth, correcting for the thickness of the bung stave.

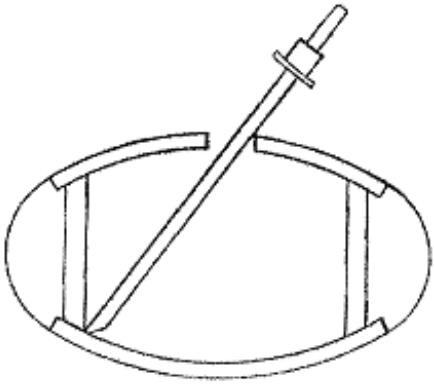

Figure 3. Gauging by the Diagonal Line (from Gauging Instructions, 1932)

Used vertically the rod also may be used to determine the 'wet' and 'dry' inch depth of a part full cask.

The Diagonal Line - The diagonal line is used to measure the approximate content of casks of similar aspect ratios and is calibrated for 1st variety spheroidal casks. It is based on the principle that solid bodies of similar type vary as the cube of their dimensions, e.g.

If a cask of 16.4 inches diagonal contains 10 gallons then a cask of 32.8 inches diagonal contains 80 gallons since -

$$16.4^3 : 32.8^3 = 10 : 80$$

The diagonal is measured as in Fig. 3, from the point of the rod in the bottom corner of the head to the centre underside of the bunghole.

Although the rod is calibrated up to casks of 240 galls capacity it is used usually only with casks of small capacity as errors increase with size.

The Imperial Line - The imperial area line is used for determining the content or ullage of cylindrical vessels. It is based on the principle that the areas of similar bodies vary according to the square of their like dimensions, e.g. -

If a cylinder of 18.79 inches diameter contains 1 gallon for every one inch depth, then a cylinder of 26.57 inches diameter i.e. $\surd(18.79^2 \times 2)$ contains 2 gallons per inch.

If the imperial line is used to measure the diameter of a cylinder it will indicate the number of gallons it contains for every one inch depth. This value, multiplied by the depth in inches, gives the vessel content or ullage.

The Head Rod as Calliper - The various calculating functions of the head rod will be described later.

The head rod is normally 45 inches long, with a central slide 1inch longer than the stock. At one end of the stock there is a brass arm about 2-3inches long with a projection parallel to and one inch longer than the stock. The slide has a brass cock, about 2 inches high, 12 inches along its length. The bottom line on the face of the stock is a line of inches and tenths from 1 to 45 inches and in older models this is continued on the slide, to the right of the cock, to 76 inches.

In use, the projection on the stock is inserted into the angle formed by the chimb (the projecting rim) and the head of the cask. The slide is opened across the diameter of the head until the cock meets the opposite chimb. The diameter is read from the line of inches (see Fig. 4b).

The Cross Calliper - This is used to measure the bilge diameter of the cask, i.e. the diameter at the centre across the bung hole. Early versions of the calliper measured the external diameter and an allowance for the stave thickness was deducted, but later versions give an apparent internal diameter allowing 2 x 1 inch for stave thickness. Measurements are taken horizontally across the bung hole and at an angle on either side to show that the casks are circular. The average of the three readings is used.

The internal diameter with the cross calliper is compared with that by the bung rod to see that they are in accord. Fraudulent practice has included the use of an extra thick basal stave or insertion of a block of wood opposite the bung hole to give the cask an apparently smaller volume from the bung rod measurements (see Fig. 4c).

The Long Calliper - This is used to determine the length of a cask. It has a similar sliding construction to the cross calliper but the arms are shorter and turn in for about five inches at each end in order to touch the heads clear of the cask chimbs.

Again the callipers give an allowance of 1 inch for each head thickness to indicate an apparent internal length.

Both the cross calliper and the long calliper readings may be corrected for the true stave thickness if required and three instruments are available for this (see Fig. 4d).

The Endometer or Head Calliper - This is used to determine the thickness of the

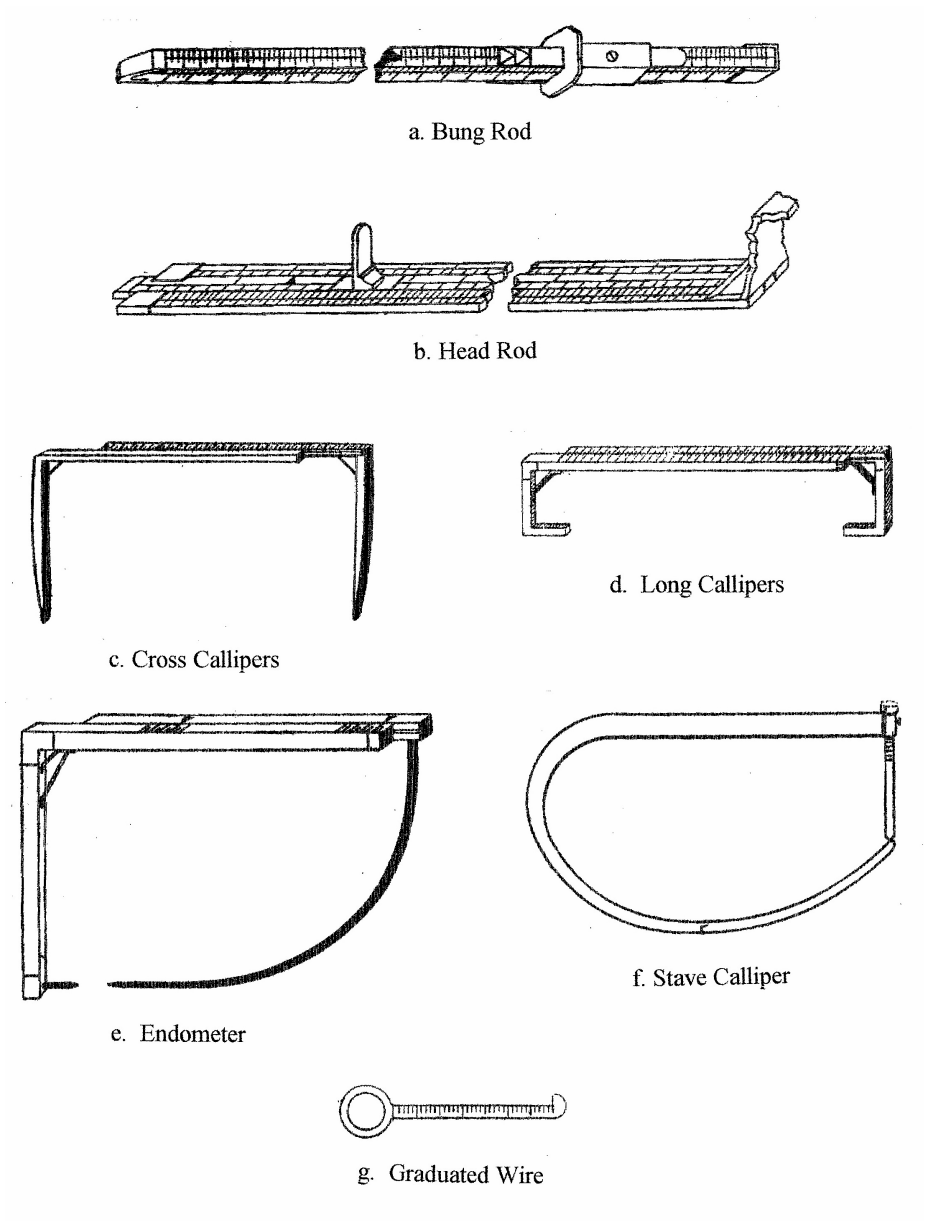

Figure 4. Gauger's Instruments (from Gauging Instructions *1932)*

end staves. When closed the pin on the vertical arm and the curved metal arm just touch. The calliper is opened, the curved arm inserted through the bung hole and brought into contact with the inside of the head. The calliper is then gently closed until the pin touches the outside of the head. Stave thickness is read on the slide (see Fig. 4e).

The Stave Calliper - The calliper has a vertical calibrated pin that is lifted to allow the calliper arm to be inserted through the bung hole. The end of the arm is brought into contact with the inside of the stave and the pin allowed to drop onto the outer surface. The stave thickness is indicated on the pin (see Fig. 4f).

The Graduated Wire - This is used to determine stave thickness at points where the endometer or stave calliper cannot reach.

It is a flat brass 'key' marked in inches and tenths with a flange at the end.

A gimlet hole is bored in the stave to be measured. The key is inserted and pulled back for the flange to lock on the inside of the hole, and the depth measured at the surface (see Fig. 4g).

Cask content and ullage calculations

The Head Rod as Slide Rule

In addition to the measurement function already described, the head rod evolved as a slide rule capable of carrying out the basic calculation associated with gauging and duty payment, including cask content, ullage, proof spirit quantities etc. The scales on the head rod are shown diagrammatically in Figure 5.

Content Calculations - The face side of the head rod is concerned entirely with measurement of vessel contents.

The bottom line of the stock and the lower line on the slide, to the right of the cock, are lines of inches for use in measurement of cask diameter.

The central line on the slide, to the left of the cock, is an experimentally derived 'spheroidal line.' This shows the inches to be added to the head diameter of a spheroidal cask in order to give the mean diameter of the cask equivalent to a cylinder of the same length and capacity.

The inverse inch line below the spheroidal line is used in conjunction with the bottom inch line on the stock to add the inches indicated by the spheroidal line to the head diameter.

The top line of the slide is a logarithmic line of mean diameters, running from 14 to 64 inches, used in conjunction with the top line of the stock, to determine the cask content. The line usually has a gauge point, a triangular brass notch, at 18.79 inches which is the diameter of a cylinder containng one gallon for every one inch depth.

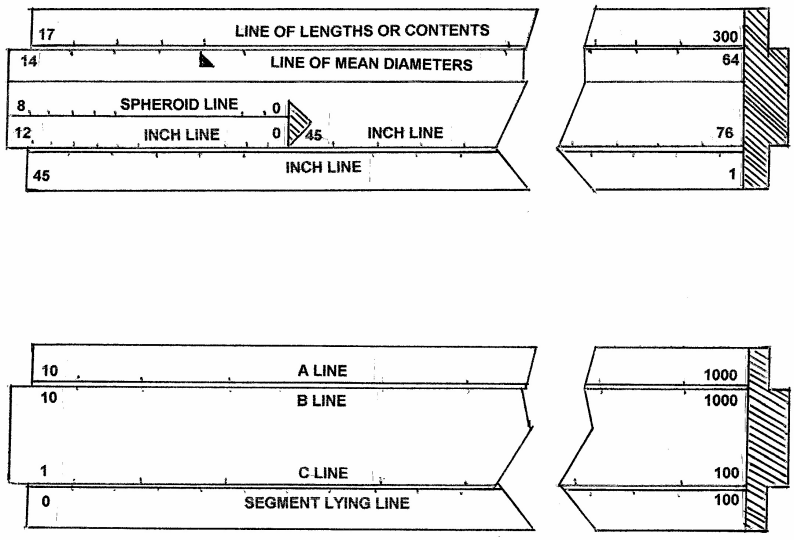

Figure 5. The Head Rod: scheme of lines (face side above, reverse side below)

The top line of the stock is called the line of lengths or contents. The numbers run from 17 to 300 and traditionally covered the volumetric range of most casks met with in practice.As with the imperial line on the bung rod, this line is based on the principle that the areas of similar bodies vary with the square of their dimensions, e.g.

If a cylinder of 18.79 inches contains one gallon per inch depth, a cylinder twice that diameter (37.58 inches) contains 4 gallons per inch depth. Thus a cylinder 20 inches long at 18.79 inches diameter contains 20 gallons, at 37.58 inches diameter it will contain 80 gallons. On the slide rule set the gauge point 18.79 to 20 on the stock, against 37.58 will be found 80 on the stock.

To calculate the content of a cask:

Assume the following measurements:
Head diameter - 27.0 inches
Bung diameter - 33.0 inches
Length - 45.0 inches
Set the brass cock on the slide to the head diameter (27.0) on the lower stock inch line, then against the bung diameter (33.0), on the same inch line, find the number that it cuts on the spheroid line (4.2). Transfer this number (4,2) to the to the inch line below the spheroid line on the slide and this will cut the mean diameter in the lower stock (31.2).
Now set the gauge point (18.79) on the

top line of the slide to the cask length (45.0) on the upper stock. Against the mean diameter (31.2) on the slide will be found the content of the cask (124 gallons).

Ullage calculations - The reverse side of the head rod, which acts as a more general purpose slide rule, has four lines, a logarithmic A line (10-1000) at the top of the stock, a similar B line at the top of the slide, a logarithmic C line (1 - 100) at the bottom of the slide and an experimentally derived 'segment lying' line (0 - 100) for partially filled casks at the bottom of the stock.

Segment 'lying' or 'standing' lines are used to calculate the ullage (or head space) in casks lying horizontally or standing on their ends. The segment lying line on the head rod is constructed to work only with the standard spheroidal cask and will give appreciable errors with any other type. It is used in conjunction with the C line to give the percentage ullage, from the bung diameter and the wet or dry dip, and then, by use of the A and B lines to give the actual ullage in gallons e.g. continuing the example above -

Bung diameter - 33.0 inches
Wet dip - 30.0 inches
Content of cask 124 gallons.

Set the bung diameter (33.0) on C, on the slide, to 100, on segment lying, on the lower stock. Find the wet dip (30.0) on C, which is against 96.75 on the segment lying line, i.e. the % of content. Now set the capacity (124 gallons) on B against 1000 on A. Against 96.75 on A is 120 on B, the 'wet ullage' (liquid volume) in gallons.

Gauging and ullaging slide rules

The wide range of these rules has been noted by Hopp.

The actual origin of the head rod is unclear, but as with long established slide rules, variants on the above description will be found, in particular pre-1823 when the rod was calibrated in old wine gallons.

The multifunctional use of the head rod may have been convenient for intensive gauging operations but its use was not without controversy. Nesbit and Little in 1822[12] considered the 45 inch head rod inconvenient for calculating content and ullage and reported that a 24 inch slide rule containing all the lines of the head rod in abridged form was in general use. This was generally called a Jerkin with the line of inches on the lower stock running from 20 to 44.

The standard head rod was inconvenient also for general ullage calculations and H.M. Customs and Excise Instructions for Officers 1932,[13] reports that two types of ullage rule, both 24½ inches long were issued for use. The first rule was a smaller scale version of the reverse side of the head rod. The second

rule had in addition, on the back, a segment standing line, issued only to officers who had to deal with such matters.

As already noted four varieties of casks were recognised generally but as might be expected there was much 18th and 19th century argument about the best form of mathematical treatment and general equation to cover the most common forms of cask. Young's variety and Hutton's variety were popular contenders. Todd and Kentish also derived equations and the debate about the best form is noted in Bateman's *Excise Officer's Manual* 1852.[14]

Bateman also discusses a gauging line the 'X' line found on some 19th century gaugers rules and attributes the invention to Woollgar. In Bateman's rule an 'X' line is in the groove under the B line on the slide as devised by Woollgar. On some Dring & Fage and Loftus rules[15] we find it on the right hand side of the stock. On one side of the rule there are 'X' lines for first and second variety casks and on the other side 'X' lines for Hutton's variety and Young's variety, marked $H^{S}V$ and $Y^{S}V$ respectively.

The object of Woollgar's invention was to shorten the calculating operation. From the ratio of the head to the bung diameter he constructed a line of gauge points directly relating to the mean diameters of the casks thus avoiding use of the spheroidal line. Cask capacity was then determined from gauge point, bung diameter and length. Since this was a 'floating' gauge point this system never seems to have been adopted officially.

Other combined gauging rods and slide rules

The head rod is but one example of gaugers trying to combine their measurement and calculating functions in one tool.

Everard's, Leadbetter's and possibly some four-side gauger's rules may bear, on the underside of a pair of slides, lines of inches, 13 - 24 and 25 - 36. By extending these slides on the 12 inch slide rule the diameter of any vessel up to 36 inches may be determined. Running beside these inch lines is a line of 'Ale Area.' This will give the ale gallons per inch depth for any circular vessel from 13 to 36 inches diameter.

Richard Knight[16] has given a detailed description of Branan's rule, from the first half of the 18th century. This combines the function of a four foot gauging rod and when split into two equal halves can be used as a slide rule.

Another example, 'A Five Piece Combination Rod and Slide Rule,' apparently pre-1826, has been described by Tom Wyman.[17]

Dip rods

Equipment of the type used by Customs and Excise was supplemented by a wide

range of ullaging dip rods for use by small scale manufacturers, stock-takers, publicans etc., as illustrated in Figure 6. They came either as straight rods or, more frequently, in trade, with folding joints or screw thread sections. They usually had a line of inches, a diagonal line and also a number of ullage dip lines. These latter showed the content of a particular cask size and were graduated to indicate the vertical wet dip in gallons.

Rods for imported wines and spirits and those for British made casks, especially beer must be considered separately.

Dip measurement of small casks of wines and spirits (say 2 - 20 gallons), which were made to the same proportionate dimensions, was probably accurate, but no reliance could be placed on larger sizes such as puncheons (72 gallons imperial) or butts (108 gallons imperial), which were imported in a wide range of dimensions and actual content.

Leadbetter[9] noted that since an Act of Parliament of Henry VIII, London coopers had been required to make wine and beer casks of defined dimensions under a penalty of 3s 4d per offence. He goes on to describe a 4-foot jointed rod with inch and diagonal beer and wine gallon lines, supplemented with accurate ullage lines for London casks. With the adoption of the Imperial measure the London Coopers re-defined the dimensions to be used for casks of each size.

It must be remembered that at the end of 19th century British beer consumption peaked at around 37 million barrels a year. In 1889 the Bass Brewery in Burton, alone, employed 400 coopers and owned more than half a million casks. For this mass production beer casks were not gauged but generally weighed full of water to ensure that they came within agreed Excise tolerances. Dip rods designed for the brewing trade were thus adequate for all general monitoring purposes.

The foregoing has been an introduction to ‘the gauger's art’ in relation to the cask - the historic container for liquid movement. There are of course other stories to tell. The cooper's craft, itself, has a fascinating history. As far as Customs and Excise are concerned gauging a cask is only half the business, they are often equally interested in liquid composition and strength! Alcohol assay is another story hiding behind a slide rule.

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Shewing Inches and Imperial Gallons and Dips for Casks 10 to 20 Gallons. Standing.

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Dips for Wine Pipes and Rum Puncheons Lying.

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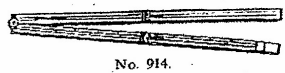
No. 912.	7/6	10/-	No. 912F.	21/-	22/6



No. 914.

No. 914. Jointed Pin Rods, for Small Casks Folding, as illustrated 7/6

No. 915. Jar Rods, 2ft. Straight 3/6

No. 915J. Jar Rods, 2ft. Folding 7/6

No. 917. **SPILE ROD,** with screw joints. For Wine and Spirits. Shewing Inches and Imperial Gallons.

No. 918. **SPILE ROD,** with screw joints. For Beer. Shewing Dips for Pins to Puncheons. Standing and Lying.

SPILE RODS.

Nos. 917–920.

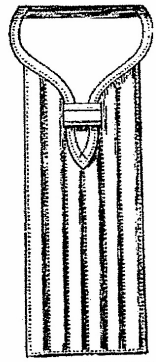
PRICES.

No.	Length.	each.
917/3.	2ft. 6in....	7/-
917/5.	5ft. ...	13/6
918/3.	2ft. 6in....	7/-
918/5.	5ft. ...	13/6

No. 919. **PLAIN SPILE ROD** (Round, 40in. long). For Spirit Casks. Shewing Inches and Imperial Gallons.
Price, No. 919, 2/- each.

No. 920. **Ditto** (Round or Square, 40ins. long). For Beer Casks. Shewing Dips—Pins to Puncheons, Lying.
Price, No. 920 2/- each.

SOLID LEATHER CASES. No. 921.



For Screw Spile Rod, 3-piece 7/-, 6-piece 10/-.

Figure 6. Gauging rods for wholesale and retail use (1920 - 1930)

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Appendix 1. Extract from *Instructions for Customs Gaugers* 1826

To Mr ...

Gauger in the Port of ...

I

You are to attend in your Office at the Custom house, or at the Station to which you may be appointed, during the hours required by Law, and that such attendance may be duly shewn, you are to enter your signature in the morning and evening of every day, (Sundays and holidays excepted) in an Appearance Book, to be kept in the Landing surveyor's Office, or in the Office of the Inspector of Gaugers at the Station, for that purpose, stating the precise time of your arrival and departure; and in case you are unable to attend your duty through sickness, you are to acquaint the Landing Surveyor for the Office Station, or the Inspector of Gaugers therewith, at or before the hour prescribed for your appearance (or as soon after as possible,) in order that another Officer may be appointed to your duty; observing, that the discovery of your absence on a false plea, will be followed by severe punishment.

II

You are not on any account to proceed to gauge any Wines, Spirits or other gaugeable commodities, until the same shall have been duly entered. You are then to take the following dimensions of each Cask accurately, viz, the length, the head and bung diameters, and the number of wet inches contained therein; from which dimensions, having made the proper allowances or deductions as are here-

inafter laid down, you are carefully to ascertain the full contents as well as the ullage contents thereof, upon which the duty will be charged

III

Before you commence gauging, every day, you must be particularly careful to examine your rules, and to ascertain the accuracy of your long and cross callipers, as from their length and thinness they are very liable to get incorrect. In taking the dimensions, you are specially to observe that the diameters of the two heads are to be carefully taken by bringing the projecting brass upon the slide of the head rod about two thirds up the chimb, so as to be level with the groove where the head joins the staves, and the mean thereof is to be considered the head diameter.

IV

You are to be particularly careful in ascertaining the bung diameter, it being of double the value of the other dimensions, first with the cross callipers, which must be used on all occasions, you are to take the horizontal diameter in three different parts of the centre of the cask, and chalk down the mean or average as the cross on the side of the bung, after deducting the thickness of the staves; you are then with the bung rod to examine the bottom and side, to ascertain if there are any irregularities in the staves or form: if the cask appears fairly made, you are to take the mean of the horizontal and perpendicular diameters for the bung dimension; should two or three of the staves at the top or bottom of the cask appear flattened, and the rest of the cask circular, you are to add to the perpendicular found, as many tenths of an inch as in your judgment you consider the staves depressed, and then; as for example - the staves of a Rum Puncheon, on boring, average eight tenths of an inch thick, you have then too little upon the cross of the cask, you are to deduct, from the perpendicular found, as many tenths of an inch as you may consider the case to require, before taking the mean bung diameter. As deceptions are frequently made use of to mislead the Gauger, the greatest nicety of judgement is required in taking this dimension.

V

All casks of irregular thickness, such as Rum Puncheons, Brandy Puncheons, Madeira Pipes, and large sized casks, it is necessary to bore occasionally to ascertain the substance of the heads and staves; you are to bore the cask in the centre of the stave, at about one third the distance from the head of the bung; and the head, in the piece next the centre, ascertaining the thickness with the graduated brass given you for that purpose. You are to cross and dip the casks as if they were an inch thick, and to add to or deduct from the bung thus found, the mean difference of the actual thickness; as for example - the staves of a Rum Puncheon, on boring, average eight tenths of an inch thick, you have then too little upon the cross four tenths, being two tenths each stave; and upon the perpendicular two tenths

- etc. etc.