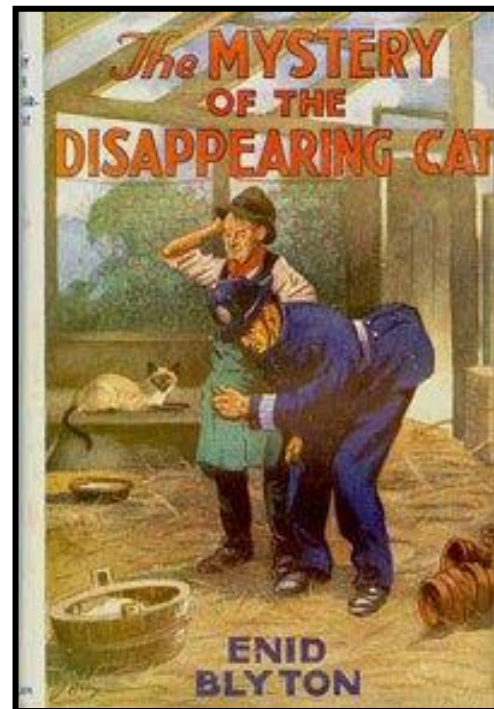


# THE MYSTERY OF THE DISAPPEARING BAKELITE<sup>1</sup>

David G. Rance

*The grand house on the corner of Longman Street and Park Avenue looked like a museum and was rumoured to house a great collection. The owner, a retired engineer called Joe, was always friendly and let us kids play football on his large front lawn. But there was something a bit weird about Joe. He would sit for hours on a bench in his garden staring at a couple of old bits of wood. One Saturday morning, near the end of our weekly game against the kids of Park Avenue, Joe ran out of the front door and wailed loudly: “it’s ..., it’s gone ..., the Blundell Bakelite ..... disappeared”!*



Although intended as a “tongue-in-cheek” tribute to the storytelling of the late and great Enid Blyton (1897-1968), behind these opening lines to a fictional tale, and common to many children’s stories, is a deeper and important moral. For this story it is how collectors often overlook the remarkable but ill-fated Bakelite slide rules from British manufacturer: Blundell.

## **Wood or plastic?**

Surely a wooden slide rule must be more tactile than one made of plastic? If they could talk, a fine boxwood slide rule with a rich patina must have “lived” more and have more stories to tell than any plastic contemporary. The one possible exception could be an all-Bakelite plastic slide rule.

Registered in 1870, Celluloid (a compound of nitrocellulose and camphor) is regarded as the first thermoplastic. But apart from a few all-celluloid rules, it was mainly used as a veneer carrying the scale divisions, gauge marks, etc. But arguably the discovery of Bakelite, nearly forty years after celluloid, should have been the dream raw material all slide rule manufacturers had been waiting for.

## **Bakelite – the king of plastics**

The son of an illiterate shoemaker, Leo Hendrik “Doc” Baekeland (1863-1944) was born and spent the first 26 years of his life living in Ghent, a municipality in the Flemish region of Belgium. Despite his somewhat impoverished background, he got a PhD in chemistry at his local Ghent University. At the start of the 20<sup>th</sup> century, after marrying the daughter of his university professor, he emigrated to the USA.

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<sup>1</sup> From a similar named story by Enid Blyton and first published in 1944.

Initially the move was to pursue a new process he had invented for developing photographic plates. Baekeland chiefly got interested in synthetic resins as a moneymaking project. In 1909 he announced and patented “Bakelite” – a mixture of phenol<sup>2</sup> and formaldehyde. By 1922 he had founded the Bakelite Corporation, a company that became the main commercial outlet for his patented synthetic resin. Bakelite was arguably the first true plastic – totally synthetic, cheap to produce, non-flammable and extremely durable. It was a revelation for industry. So much so that Leo Baekeland was featured on the front cover of the September 1924 edition of the prestigious Time Magazine.

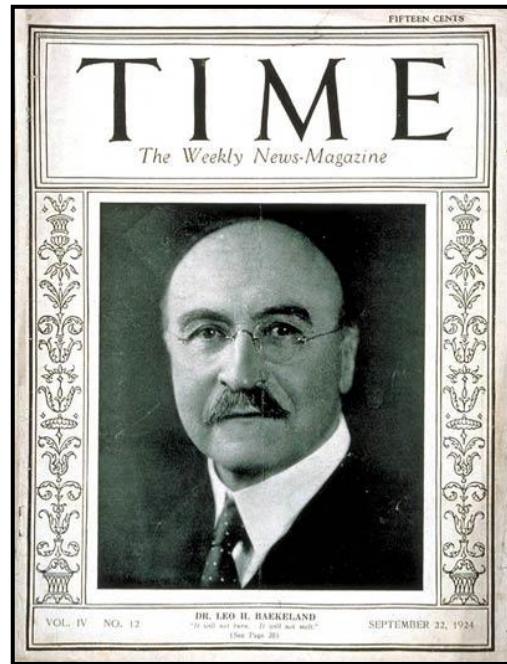


Fig. 1: Leo Baekeland

When made, compression moulded Bakelite is virtually black although limited colour variations from dark-brown through to a yellowish-brown are possible<sup>3</sup>. Importantly it was also the first thermoplastic that held its shape after being heated. This meant its range of uses was almost endless – for electrical insulation, for all sorts of “kitchenalia”, for radios, for telephones, for camera’s, for jewellery and ... even for slide rules.



Fig. 2: Examples of the diversity of Bakelite products: electric switches and sockets, a Kodak “Baby Brownie” and a telephone

Today Bakelite is a brand name of Hexion Specialty Chemicals, Inc, USA.

### ***Bakelite slide rules***

Given its amazing properties it is surprising that Bakelite was not universally adopted as the material of choice by the slide rule manufacturers of the day. However, apart from one major manufacturer, most only used Bakelite sparingly, if at all. One of the rare but more well-known examples is when UK mathematical instrument maker

<sup>2</sup> Also known as carbolic acid.

<sup>3</sup> Later a purified and transparent type of cast Bakelite, trade name “Catalin”, was developed. It could be dyed to any colour and was used, among many other things, to make a limited number of slide rules.

W.F. Stanley & Co Limited switched during 1946 from mahogany to Bakelite for their innovative long-scale cylindrical Fuller slide rule.

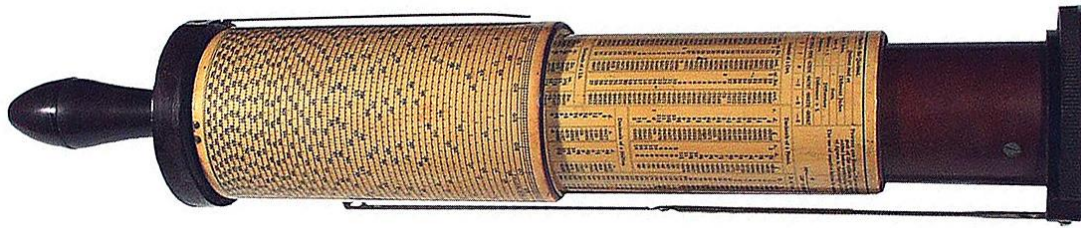


Fig. 3: Stanley Fuller Bakelite cylindrical slide rule post 1946

One possible explanation, besides the brittleness of early Bakelite, could be that slide rule manufacturers simply preferred to use their own plastic derivatives. For example, Nestler had “Anagit”, Faber-Castell had “Geroplast” and “Ivorite” was the Keufel & Esser’s version. But one mainstream slide rule manufacturer did opt to make a series of slide rules in Bakelite: UK based **Blundell Rules Limited**.

### ***Blundell’s ill-fated love affair with Bakelite***

Blundell Brothers Limited was a family drapers and furnishers business established in 1852. Blundell’s had their own workshop for their felt-hood business and dyeworks. The company started experimenting with slide rule production in 1945. Three years later **Blundell Rules Limited** (BRL), with a manufacturing base in Luton (north London), was founded by Henry Alison Blundell (1896-1990). He was the grandson of Henry Blundell, the founder of the family business. As Managing Director, Henry Alison took a keen personal interest in the company’s fledgling slide rule business. He was helped by a German immigrant working for Blundell Brothers: Fritz Hammelburger. Before leaving Germany in the 1930’s, Hammelburger had gained valuable experience in how to make slide rules. He was the mastermind behind the pioneering and innovative process that they decided to use – so much so, that Blundell Brothers Luton Ltd and Fritz Hammelburger (jointly named) received a British Patent for it on May 24<sup>th</sup>, 1948.

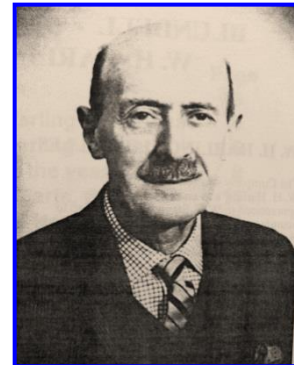


Fig. 4: **Henry Alison Blundell**

Patent, **GB 602286**, was granted for: “*A new or improved process of engraving, and articles engraved by such process*”. Perhaps surprisingly, only a few Blundell slide rule related patents exist. This is because Blundell, like many other slide rule manufacturers, often found it too time-consuming and too costly to get an innovation fully protected by a patent – especially as the process involved annual renewal fees and had to be repeated (and repeatedly paid for) for every country. So Blundell, and most manufacturers, usually found it more cost effective to make an inexpensive “Patent Application” based on just a provisional specification. For example, in the UK at the time such an application offered immediate “exclusive rights” protection for 9 months. A further extension, normally 1 more month, could be bought before a full specification had to be filed. Without a full specification the original application would, by default, simply lapse. This is why “*Patent Appl.*” is often found on slide rules but when searching for any related patent, none exist. Like Blundell, most

manufacturers opted instead for paying a modest fee to get some initial protection – at least enough to exploit the initial competitive edge and get the all-important jump on their competitors.

However, Blundell Brothers/BRL clearly believed the enamelling and engraving nature of the process they had developed was a world-beater.

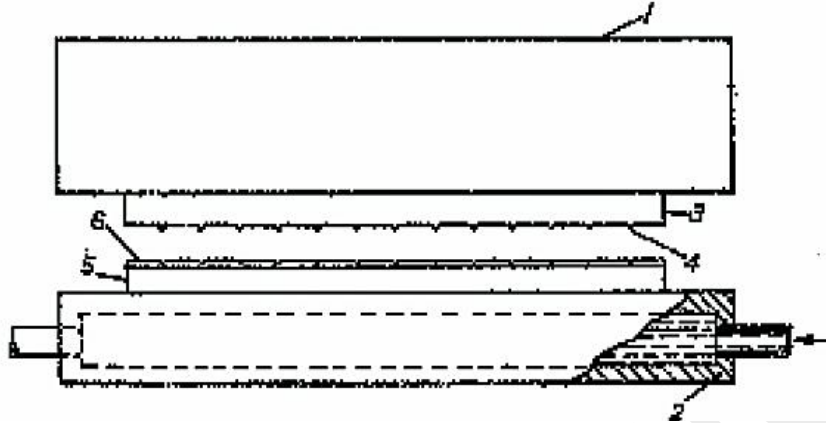


Fig. 5: Diagram submitted as part of the patent application

After being cut and milled to size, the Bakelite stocks and the slides were spray-coated with white stove enamel paint – probably supplied by Jenson & Nicholson of London. They were then reheated and the scales, etc impressed into the softened enamel with preheated metal dies. After cooling down, the scales in relief were hand-filled with black or red paint and polished. Early on, for most types, just the fronts of the stocks and the slides were spray-coated. Later it was discovered that by spray-coating both the fronts and the backs of the stocks this helped increase stability and prevented warping in the Bakelite.

Having gone to the expense of getting full patent cover for their process, Blundell clearly saw a big future for Bakelite slide rules and were expecting their patented process to pay rich dividends for many years to come.

### ***Blundell's amazing range of Bakelite rules***

For a short three-year period, 1947 to 1949, Blundell Brothers, and later BRL, marketed a range of eight standard and at least two special closed frame rectilinear laminated Bakelite slide rules. Apart from one 5-inch version all were 10-inch models. The “5-inch” pocket model followed the common convention for size by being the length (without scale extensions) of the D scale. However, “10-inch” does not match the length of a D scale (with or without scale extensions) on any of the models in the range. So although catalogued as 10-inch models, the D scale length is 9½ inches. The size was not the only unconventional aspect. Blundell also opted for a somewhat idiosyncratic choice of scale annotations for their standard slide rules.

Significantly around 1948 Blundell also made some specially commissioned Bakelite models. The earliest is probably *The Laker Time/Speed Calculator* for Firth Brown Ltd. Later came the *Illumination Calculator* and *Angle Calculator* for Holophane Europe Ltd. In later years, such special commissions were to become a “trademark” of Blundell’s slide rule production and success.

Category	Model # (usually stamped on the front face)	Size	Cost <sup>4</sup> (£ s d)	Scale layout & annotations Cube = <b>K</b> Rec./ <b>Rec.</b> = <b>CI</b> U.L./ <b>U.L.</b> = <b>LL2</b> L.L./ <b>L.L.</b> = <b>LL3</b> MAN. = <b>L</b>
General	G.1 Students	10-inch	£1.10.0	K A = B Rec. C = D L (Back: plain uncoated Bakelite)
	G.2	10-inch	£1.18.0	K A = B <b>Rec.</b> C = D L
	G.5	10-inch	£2. 5.0	Front: K A = B <b>Rec.</b> C = D L Back of slide: = S S&T T =
Electrical	E.3	10-inch	£1.18.0	Voltage Drop A = B <b>F°</b> <sup>5</sup> <b>Cos.</b> C = D Dynamo / Motor Efficiency
Log-Log	L.4	10-inch	£1.18.0	U.L. A = B <b>Rec.</b> C = D L.L.
	L.6	10-inch	£2. 5.0	Front: U.L. A = B <b>Rec.</b> C = D L.L. Back of slide: = S S&T T =
Pocket	P.8	5-inch	£0.17 6	A = B Rec. C = D
Universal	U.7 Wide-Faced	10-inch	£3. 3.0	<b>U.L.</b> Cube A = B S S&T T <b>Rec.</b> C = D MAN. <b>L.L.</b>
Special Commissions	Laker Speed/Feed Calculator	10-inch	not known	Front: 4 specialist scales for calculating machine tool cutting Back: constants/conversion factors
	Holophane Illumination Calculator	10-inch	not known	Front: 8 specialist scales for calculating illumination levels Back: instructions for use
	Holophane Angle Calculator	10-inch	not known	Front: 6 specialist scales for calculating angles for illumination Back: instructions for use

Table 1: **Range of Blundell laminated Bakelite stove-enamelled slide rules**

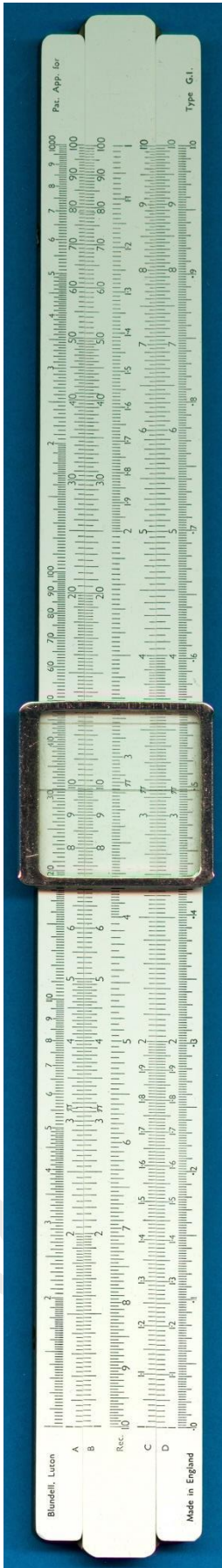
Most slide rules had a conversion table of various units and measures (the model E.3 also had wire gauge sizes and wire resistance tables) engraved on the back. The 10-inch rules also had a narrow groove horizontally cut through the centre of the well of the stock. This weakened the stock enough to provide some needed tension for the slide. But some early production run 10-inch slide rules have just two, on the left and right-hand sides, short groves cut into the well of the stock and a few were of plain machined Bakelite with no groove(s) at all. Perhaps not unexpectedly, a promotional company name and/or logo was often engraved on the back of the 5-inch pocket model.

A picture gallery of all the laminated Bakelite stove-enamelled slide rules follows:

<sup>4</sup> The advertised retail price in “money of the day” - i.e. pre-decimal British pounds sterling.

<sup>5</sup> The **F°** scale is a “scale extension” coming after the right-hand end of the B scale.

Model: G.1



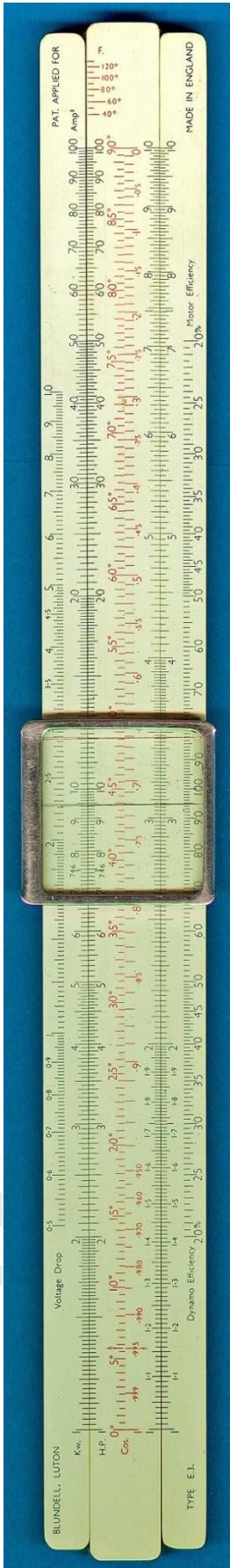
Model: G.2



Model: G.5



Model: E.3



Model: L.4



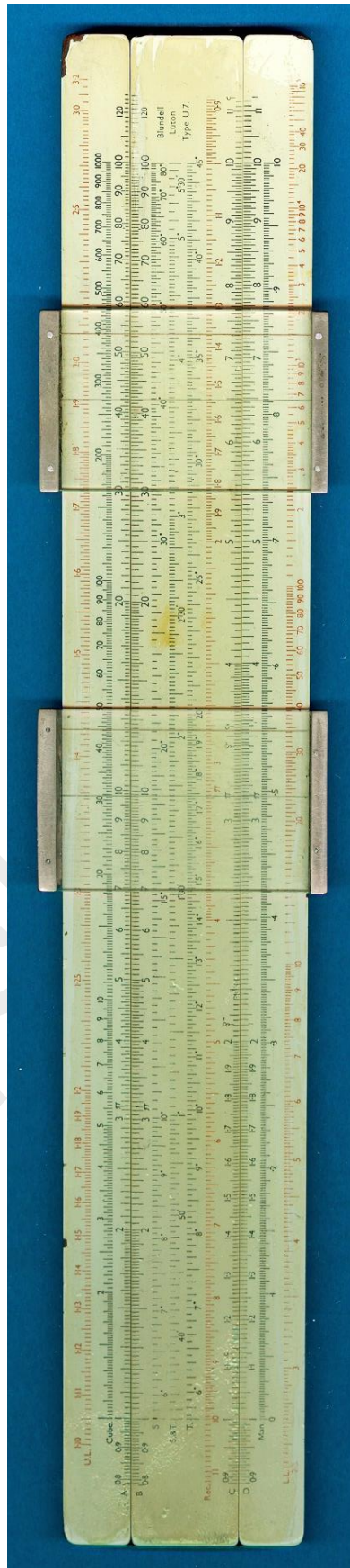
Model: L.6



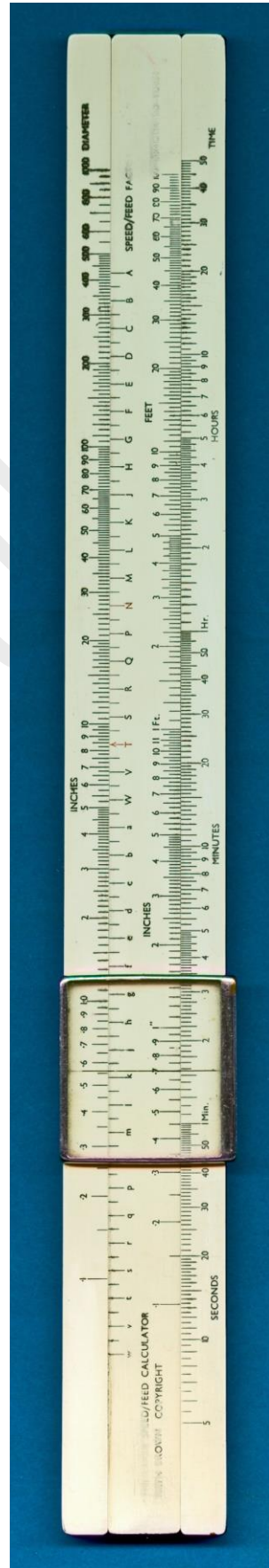
Model: P.8



Model: U.7

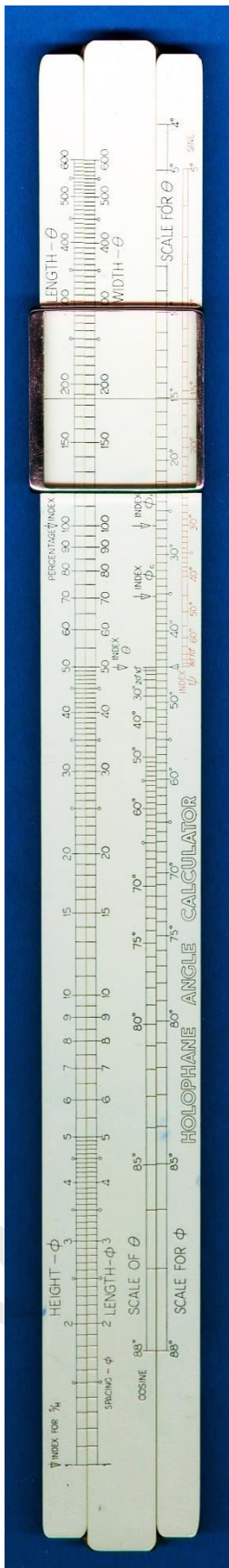


Model: Laker





## Angle Calculator



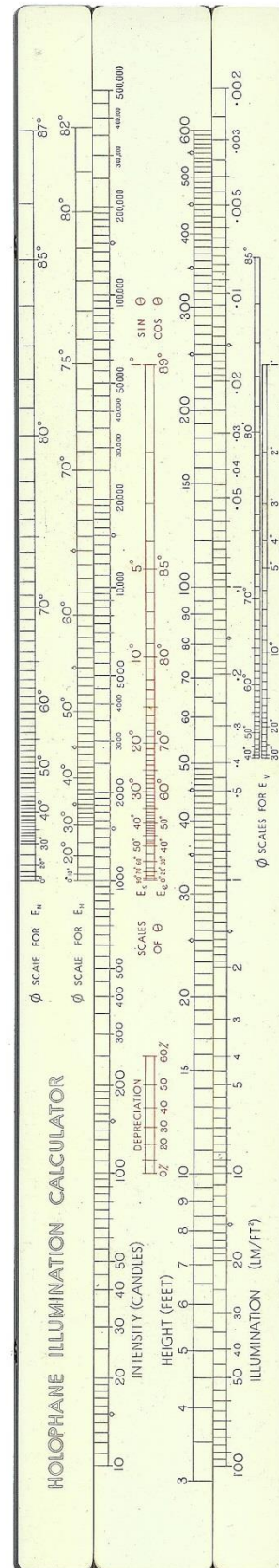
## Holophane "Specials"



**Holophane Limited**  
Elverton Street  
London SW1  
England

(1967 the company moved to  
Milton Keynes and in 1973 it  
was renamed  
*Holophane Europe Ltd*)

## Illumination Calculator



Apart from the G.5 and L.6 none of the models had scales on the back of the slide. Gauge marks were limited to all having “ $\pi$ ” (Pi) plus “746” (Kw. to British HP conversion factor.) on the model E.3. They all had a chrome-plated brass or painted black glass framed cursor. For the 5-inch model it was acid etched with one black central hairline. For the standard 10-inch models it had two (1 black and 1 red) full-line hairlines. The second red peripheral hairline, offset to the right of the central black hairline, was an alternative to a “1.128” gauge mark for calculating the area of a circle. When the red peripheral hairline was set to a given diameter on the C/D scale, the central black hairline gave the area on the A/B scale. The model L.6 also had two extra small glass cursor window inserts at either end on the back of the stock.

10-inch slide rules came in a rigid cardboard case covered in either blue or dark-green paper with “**BLUNDELL**” printed in gold lettering underlined in the top right-hand front corner and a small white sticker showing the model type on the right-hand side edge of the case. Moulded Bakelite cases and imitation leather covered wood hinged cases were available at extra cost. The pocket version came in a fawn soft-leather sheath case.

### ***Bakelite process fatally flawed***

In the accompanying blue instruction booklets BRL glowingly cited results from 1948 from the UK National Physical Laboratory that as a raw material: “*the dimensional stability of Bakelite is superior to Boxwood and Boxwood-Ivory.*” However, the BRL production run of Bakelite slide rules was short-lived and eventually abruptly stopped because the process developed by Hammelburger was, from the outset, fundamentally and irrevocably flawed! Bakelite does not shrink uniformly after being (re)heated. The telling differences in the thicknesses of the 10-inch Bakelite stocks (mostly 5/16 inch) and the thicknesses of the slides (mostly 1/8 inch) meant they critically shrunk disproportionately to each other during the coating and engraving stages. So invariably the scales on the stocks and the slides did not line up correctly and lacked the required accuracy. The production waste rate is reported to have been a horrendous 40%. But given the nature of the flaw in the process, it is much more likely that 50-60% of all the Bakelite slide rules ever produced were rejects.

In a forlorn attempt to improve the waste rate, Hammelburger started by making sure the stock and slide at least came from the same batch of Bakelite. This is why a 3-digit, and later a 4-digit, blind number stamp can usually be found in the centre of the well of most Bakelite rules. However, unlike the Faber-Castell and the Aristo coded blind date stamps, the Blundell blind number stamp does not give a reliable year of manufacture. It is not even an indication of the how many slide rules were made - it is just an insignificant batch number. The disastrous shrinkage problem also meant the traditional narrow groove cut horizontally through the well of the stock was often not enough to provide acceptable tension between the slide and the stock.

### ***Flaw finally discovered***

The first Bakelite slide rule made by Blundell Brothers was the pocket 5-inch version. Although understandable, with hindsight it is unfortunate that Blundell opted to make the P.8 first. Being wafer-thin, just a 1/4 inch, for both the stock and the slide, it is

possible that the problems BRL later faced were masked or did not show up. As despite all Hammelburger's efforts, nothing could correct the fatal flaw in the process.

Hammelburger kept the financially crippling high waste rate from Henry Alison by hiding all the rejected slide rules in a disused on-site air raid shelter. When Henry Alison eventually discovered the mountain of rejects, Hammelburger was summarily fired. A renowned gentleman, Henry Alison also had a "determined to succeed/roll up your sleeves" stubborn streak in him. So with the help of Harold Jones, Kenneth Oldroyd, Leslie Manyweathers, Victor Best and Richard Cross, who had all joined BRL from the Blundell Brothers felt-hood business, he set about fixing the problem.

It is unclear when Henry Alison finally accepted the process was irrevocably flawed. At first he sold off all the imperfect but usable slide rules as cheap "Export Rejects." Then Leslie Manyweathers, who took over Hammelburger's technical role, came up with an innovative solution to the long-running problem of inadequate tension between the slide and the stock. Mostly found on slide rules with a 4-digit blind batch number, Manyweathers' solution was to add two recessed sprung tension adjustment pins in the top edge of the Bakelite.



Fig. 6: Sprung metal tension adjustment pins

The pins were stiff spring wires arranged in a straight bore in the body of the rule. They stopped short of being the full-width of the rule but they can be clearly seen passing through the narrow groove horizontally cut through centre of the well of the stock.

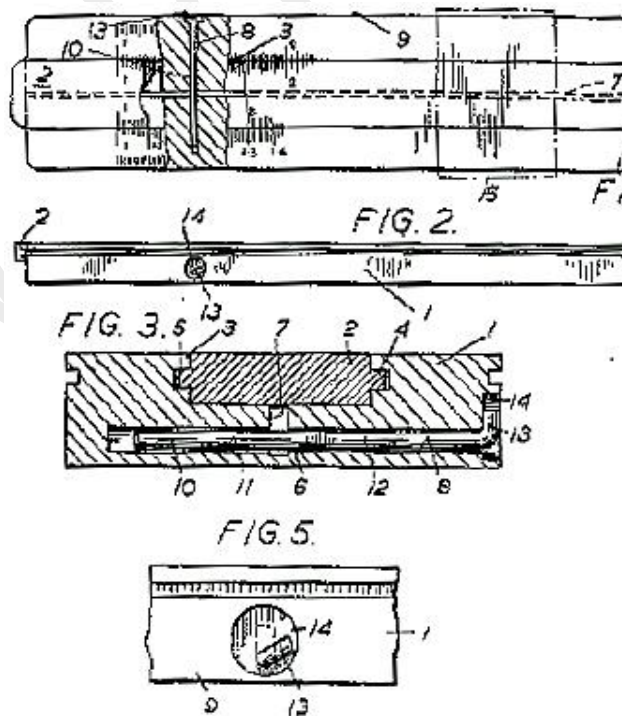


Fig 7: Diagram submitted as part of the patent application

The tension wires/pins had a round cross-section the same diameter as the holes. This meant the holes provided a snug fit and when inserted, the wires were slightly twisted so that the spring became bent and “locked” into place. A leaflet supplied with such rules explained that a slight turn of the recessed pinhead, clockwise or anticlockwise with a pointed instrument, was enough to increase or decrease the upward pressure/friction and the tension between the stock and the slide.

BRL clearly felt Leslie Manyweathers’ invention was the “silver bullet” they needed. So much so, that they patented it. A Patent Application with a full specification was made on May 3<sup>rd</sup> 1949. Eighteen months later, on October 18<sup>th</sup> 1950, BRL and Manyweathers (jointly named) were granted British Patent: **GB 244944**. The waste rate for the latter years of production is unknown. It was reduced but the tension adjustment solution could only alleviate rather than cure the basic problem that after being heated, different thicknesses of Bakelite shrink disproportionately. However, tension adjusters continued in use for many years in later ranges of BRL plastic rules.

Given the short three-year production run, a dating guide is almost superfluous. However, the modifications made by Hammelburger, Manyweathers and known key dates do help provide a probable date of manufacture or at least a guide to whether a Bakelite slide rule was made early or late in the production run.

<b>Early 1947</b>	<ul style="list-style-type: none"> <li>- P.8 model without a conversion table or an inch/cm scale on the back</li> <li>- models with a plain/unsprayed back<sup>6</sup></li> <li>- 10-inch models without any groove(s) cut in the well of the stock</li> </ul>
<b>1947</b>	<ul style="list-style-type: none"> <li>- 10-inch models with just two short grooves cut into the well of the stock</li> <li>- models with a 3-digit batch number</li> </ul>
<b>1947 to mid 1948</b>	- models with the text “ <i>PAT. APPLIED FOR</i> ”
<b>After May 1948</b>	- models with the text “ <i>PAT.NO. 602286</i> ”
<b>1948 - 1949</b>	<ul style="list-style-type: none"> <li>- models with a 4-digit batch number</li> <li>- 10-inch models with tension adjustment pins</li> <li>- models emblazed with a <b><i>BRL</i></b> logo</li> </ul>

Table 2: **Timeline/dating guide for laminated Bakelite slide rules**

### ***Disappearing Bakelite?***

The most crippling flaw with the Bakelite process was the shrinkage problem but it was not the only telling defect. The spray-coating of white enamel did not always stand the test of time. Occasionally, as shown by the colour differences of the examples shown in the picture gallery, some of the engraved text and parts of the scales or the coating itself would discolour, fade or literally start to “disappear”.

Extreme fading was particularly common with the pocket 5-inch rule. The inherent defect may have been exaggerated because the enamel coating on the P.8 was

<sup>6</sup> On the G.1 model for students it may have always had a plain back to reduce costs.

naturally thinner. But in some severe cases the enamelling can become mottled and almost translucent.



Fig. 8: Mottled/disappearing facings of a P.8 pocket slide rule (cursor removed)

### ***So what happened?***

Despite the disaster with Bakelite and Hammelburger’s flawed process, Henry Alison’s reason for setting up BRL in 1948 had not fundamentally changed. Post WWII Blundell Brothers had spotted a market opportunity because there was a shortage of slide rules in the UK – most of the major European manufacturers were all based in Germany. So even after their debacle with Bakelite, BRL were still convinced that there was a gap in the market for a leading British based slide rule manufacturer.

So BRL switched to using Poly Vinyl Chloride (PVC) as their base raw material. Importantly this thermoplastic polymer remains stable when (re)heated. BRL initially opted for “Astralon”, a proven product from the German suppliers: Dynamit-Noble AG. However, they soon switched to “Cobex” from BX plastics. This product was cheaper, more suited to pressure moulding and it could be sourced from the UK rather than Germany. BRL also salvaged some good from the ill-fated Bakelite production run. The standard models and the scale layouts chosen for the laminated Bakelite range become the foundation for their successful follow-on first series (1949-1958) range of closed frame rectilinear PVC slide rules.

<b>Size</b>	<b>Bakelite Model #</b>	<b>PVC<sup>7</sup> Model #</b>	<b>Comments</b>
10-inch	G.1	AG 1	
10-inch	G.2	AG 2	
10-inch	G.5	AG 5	
10-inch	E.3	no direct equivalent	E.3 did not sell well enough for a straight reissue. So it was replaced by a new range of 3 redesigned electro 10-inch models (E 13/18/25).

<sup>7</sup> The series included many more slide rules but only the straight Bakelite equivalents are listed.

Size	Bakelite Model #	PVC <sup>7</sup> Model #	Comments
10-inch	L.4	AL 4	
10-inch	L.6	AL 6	
5-inch	P.8	no direct equivalent	P.8 was replaced by a new range of 8 redesigned pocket 5-inch models (P 10/14/15/16/17/19/28/31).
10-inch	U.7	AU 7	

Table 3: Laminated Bakelite models and their replacements in the 1<sup>st</sup> PVC range

### Lessons learnt

Possibly being a glutton for punishment, BRL did go on to produce several aviation load adjusters and even one 20-inch slide rule made from Bakelite. This desktop model was part of the BRL “ivory co-polymer” follow-on range. The “Wide Faced” T.20 was the only slide rule made of Bakelite rule in the new range but now PVC (Astralon) facings replaced the spray-coated stove-enamelling.



Fig 9: Bakelite desktop T.20 Technicians Log-Log slide rule  
(scale layout: LL1,LL2,A / B,CI,C / D,L,LL3)

The closed frame rectilinear desktop model had no batch number but it did have 4 tensioning pins on the top side edge and 4 chiselled out 1¾ inch long recesses - one in each end of top and bottom side edges of the Bakelite stock. Having PVC rather than spray-painted facings and the recesses in the stock may have alleviated some of the inherent shrinkage problems with Bakelite. It is rare model as only a few were made in one year: 1950.

But perhaps the most valuable lesson BRL would go on to exploit from their ill-fated laminated Bakelite range was marketing special commissions or, on request, reproducing a slide rule from another manufacturer that was no longer being made. For example, *Holophane Ltd* was clearly pleased with their Bakelite special commissions because more than two decades on, they commissioned a modern duplex rectilinear PVC version that combined the old Illumination and Angle Calculators in a single slide rule.

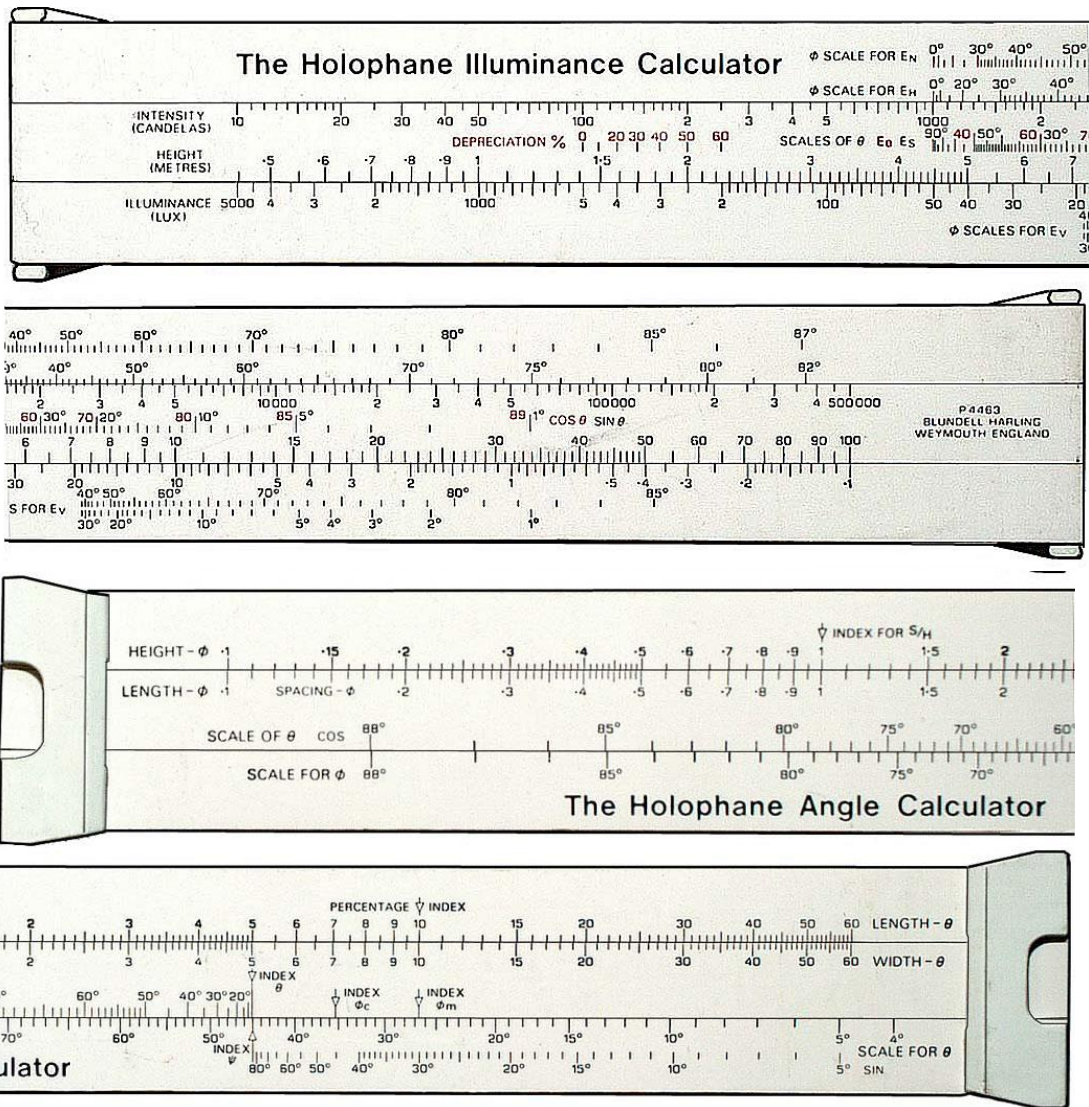


Fig 10: Blundell P 4463 Illuminance & Angle Calculator from circa 1975  
(one such slide rule is part of the UKSRC Blundell Archive)

As can be seen from the accreditation on the right-hand end of the slide on the front face, by 1975 BRL had become Blundell Harling Limited (formed in 1964 after purchasing W.H. Harling Ltd). The factory and production had also moved from Luton to Weymouth on the South Coast of England. The Holophane PVC slide rule was supplied as part of the “P series”<sup>8</sup>. By the time the production of slide rules had stopped, this series included over 5000 specially commissioned models.

### ***So the moral of this story is .... ?***

Despite Bakelite and their patented process not turning out a world-beater BRL, and later Blundell Harling Limited, went on to be a highly successful manufacturer of slide rules. They also managed to exploit the idea of special commissions much more than other slide rule maker. Blundell Harling Limited is still trading but these days they only make slide charts.

<sup>8</sup> Best considered as a running list of client orders with a serially allocated “P” numbers.

Do look out for the uncommon BRL Bakelite slide rules – they are easily overlooked since dark Bakelite can easily be mistaken for aged mahogany. If in doubt, look for the faint but unmistakable whiff of formaldehyde (another possible reason for the fading) when the resin edge is briskly rubbed with a soft cloth. There may also be other, as yet unknown, specially commissioned models. Any of the BRL Bakelite slide rules would make a great addition to any collection. But do look after the spray-coated enamel coating – especially on slide rules from early in the production run. Or one day, like the fictional *Joe* in my introduction, the scales on your prized Bakelite slide rule might have all but “disappeared!”

## **Acknowledgements and bibliography**

I could not have solved this “mystery” without help:

- **Peter Soole:** retired Technical Director of Blundell Harling Limited. Peter joined Blundell Rules in 1960 (some thirteen years after Blundell’s had stopped making Bakelite slide rules) and went on to design and sell many of their most successful slide rules and navigational aids. Despite modestly claiming only a past professional interest in slide rules, his inside working knowledge of Blundell’s and his willingness to answer my many, many questions was invaluable.
- Collector friends: **Robert Adams Colin Barnes, Peter Hopp, Klaus Kühn, David Nichols, Otto van Poelje and David Riches** for images, instruction booklets and lots of helpful information.
- **Eric Clark:** a fellow collector who in 2014 enabled me to add the missing desktop T.20 Bakelite slide rule to my collection.
- **Dr. Günter Kugel:** a fellow collector friend who in 2016 kindly donated the later discovered Laker Speed/Feed Calculator specially commissioned Bakelite slide rule to my collection.

1. **Barnes, Colin:** “*Blundell Rules Limited – early years*”, UKSRC Slide Rule Gazette ISSN 1472-0000, Issue 7, Autumn 2006, Pg. 1.
2. **Blundell Rules Limited:** “*The ‘Blundell’ Slide Rule*”, leaflet ref: 3284/10M/4/48/57, circa 1948.
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