THE WESTON MODEL E703 LIGHTOMETER

The model E703 Lightometer was produced by Weston both in the UK and the USA, as with the Master series of exposure meters. Unlike the exposure meters however, this simple compact unit (not much larger than a Master Universal) does not have an exposure calculator dial but purely a direct readout from the meter scale in foot-candles. It was evidently produced in great numbers (possibly equivalent to the Master series), yet remains largely unrecognised, undiscovered and unappreciated – the ‘Cinderella’ of Weston’s family of light meters.

The reasons are straightforward: Firstly, though compact and well designed, it was never aimed at the photographer as an instrument for assessing exposure, but at a completely different and vital field that today, we just don't think about, and that is the assessment of lighting levels in the workplace in all of its forms, be it in a factory, laboratory, when working in fine detail, reading or an office environment. Engineers, production managers, safety inspectors and many other personnel would have had need of one and the units would have been marketed, advertised, distributed and sold using trade publications and channels. That's a long way from the photographic magazines on the newsagent's shelf, or the high street camera shop.

Secondly, Weston manufactured a large number of them to bespoke requirements so, while many of them bear the Weston name directly, many others display the name of the electrical or industrial/office supply company that commissioned them. In my own collection there are examples from Siemens, Better Vision, Crompton, Benjamin, the Electric Light Company, Sight Light Corporation and Westinghouse. No doubt there are many from other companies out there, if you happen upon them. It is probable that, for much of their production life, these meters were distributed *exclusively* by the Sight Light Corporation in the United States at least, which is a further factor that masks their identity.

And, just like Chinese Terracotta Warriors or Cabbage Patch Dolls (remember them?) no two of them appear to be exactly the same, no matter how many you come across. Differences between the US and British models notwithstanding, Photronic cell variations, luminance ranges, badging, patent numbers, meter face legends, meter apertures, colour coding of workplace levels, level markups on the meter face and back plate information are all at variance. Oh! And that doesn't include a permanently mounted incident light integrator (the Invercone on an exposure meter) on some examples.

Fig.1: The Westphalen Exposure Meter, 1931, George Eastman Collection, Rochester, USA. Picture courtesy of S A Spaans[1]

Signature Design Features and Positioning of the Model E703 in Early Luminance Meter Development

The E703 meter was evidently on of the early implementations by the company of their recently developed Photronic cell, which must have been fully commercially available from 1931. Simon Spaans identifies its use by Leonard Westphalen in what appears to be the very first ever photovoltaic exposure meter (fig.1). This predates Weston's own landmark model 617 of 1932 and uses, in all probability, a galvanometer also of Weston origin. The scale is marked up directly in camera f stops and, with a rotating baffle over the cell, offers dual range light reading capability.

This incredible unit, incorporating a degree of innovation ahead of Weston's own design momentum, deserves referencing in this document because it shares principal design features fundamental to the Weston E703:

These features consist of the basic compact 'up and over' arrangement of the photronic cell and meter in the hand-holdable housing. Though an exposure meter, rather than just a light meter, the Westphalen is familial with the E703 in that it presents the cell upwards for the reception of incident (and not reflected) light. So it is arranged on the same face of the unit as the meter, and not on the reverse face as is common to the Weston family of photographic exposure meters designed for reflected light measurement.

Though the Westphalen meter returns an f number (camera lens aperture), its relation to the E703 also lies in the absence of a third component, the exposure calculator dial. This was a notable innovation by Weston, turning a simple light meter into a versatile and powerful instrument for establishing photographic exposure. For a workplace light meter it is not necessary, so the Westphalen and the E703 appear as 'brothers in arms'.

Fig.2 The x5 (lower) and x10 (upper) baffles (multipliers) available for the Lightometer, which can be placed directly on the cell to allow for measuring higher lighting levels.

A blind (or baffle) on the Westphalen can be rotated over the cell to reduce its sensitivity, thus allowing the meter needle to respond to an increased range of brightness levels, marked as a dual range on the meter scale. Whilst not replicated exactly on the E703 Lightometer, circular perforated baffles, placed on top of the cell and known as multipliers, were provided to step down the meter's sensitivity so as to give a linear meter response at higher lighting levels (fig.2). Typically they have a multiplication factor of x5 or x10 and, as can be seen illustrated later in this article, were of various designs. Generally, no accommodation was made for these on the meter scale, basic maths on the part of the user being required to arrive at the correct measurement in foot-candles.

The E703 model was, in the 1930s, the most basic model of luminance meter that Weston made, but certainly not the only one. In monograph B-8 published by the Weston Electrical Instrument Corp[(2)], the unit is described as the most basic configuration of Photronic cell, delivering a current directly proportional to the light falling on it, which is then connected to the micro-ammeter. The un-credited monograph then continues to indicate how electrical shunts (resistive components) can be employed in the circuitry to allow for multiple ranges of increased luminance levels to be measured. Three other principal models of luminance meter were

produced by Weston in the US during this period from the ‘30s in parallel with the production life of the E703. They were larger and had three-way switches for these shunt networks:

The earliest, the model 603 was a magnificent unit housed in a wood and metal casing with a two-celled probe on the end of a flexible cable. This allowed for lighting measurement in awkward, hidden and recessed spaces in addition to the wider work environment, vastly increasing its capabilities. A larger and more sensitive meter gave a more accurate readout with three ranges marked up, and twin cells on the probe allowed for greater response to low light. The end result was an instrument capable of measuring a huge luminance range.

The model 614 was a book-fold unit in bakelite with the cell in an adjustable angled mount. As with the 603, it had the three-range capability with a switch. A later variant of this employed a battery to boost the signal and increase the unit’s sensitivity to low light.

The post-war model 756 was a precision unit similar to the 603 in specification, along with its three range switch and twin celled cable mounted probe. Superseding the 603, the meter box was made of bakelite. There were several variants of this model and, as with the E703, some of them appear as bespoke items badged for other companies.

Fig.3 A direct comparison between the UK model E703 (left) and the US model (right).

Basic Production Timescale of the E703 and Differences between US and UK Models

The exact period of manufacture of the E703 is difficult to gauge. Weston’s B-8 Monograph mentioned above certainly indicates it was well established both in the United States and Britain by 1935 and it is likely that production of the model would have been concurrent with the Model 617/1 Photronic exposure meter produced in America, fixing E703 production as early as 1932-33.

Early British examples are marked up as being produced in Surrey, and this would have been at Weston’s British subsidiary (Weston Electrical Instrument Co.) in Surbiton, which had been established since 1907[3]. The E703 would have probably been the first instrument based on a photovoltaic dry cell (or Photronic cell) made in the UK and is still seen frequently on internet auction sites. Later UK examples however are marked up as Sangamo Weston. From 1936 the

original Surbiton company was acquired by the British Sangamo Co. which became the new subsidiary of Weston in Newark, America. In Britain, all manufacturing was soon moved to their Enfield site. It is possible that manufacture of this UK model continued (with a hiatus during the Second World War) into the mid ‘50s. It is also possible that Sangamo manufacture in the UK ceased much earlier and the British market was then supplied from American imports. By the ‘60s, the E703 would have been superseded by new models of compact luminance meters: notably the 719, S5.11 and the S85.

American models (marked as just 703 without the ‘E’) would certainly have come to market at the same time as the UK models in 1932/33, if not before. Proof that manufacture continued beyond 1954 in the US is in evidence on the long established website: Westonmeters.org.uk. It has an example illustrated and boxed from Daystrom[(4)]. This would have been manufactured by the Weston Instruments division of Daystrom Inc. The original US company, Weston Electrical Instrument Corp., was bought out by Daystrom in 1954[(5)] so this unit must be later.

Figure 3 shows the British and American models side by side. What is immediately apparent is that the UK version on the left is larger than the US model, is squared off at the sides and has a grained molded pattern on the bakelite front face, compared to the smooth flat face of the American model. The bakelite shells do not appear to have altered over the production life of either the UK or US versions, save for the meter aperture on the UK model, specifically where it offers up the needle zeroing adjustment.

Fig.4 The British model E703 (left) has a larger profile than the US model (right) with squared-off sides and patterned finish on the bakelite shell, in comparison to the smooth finish on the US model.

Despite the apparent difference in size (fig.4), the UK and US models share an identically sized and shaped footprint at 4 5/8” x 2 5/8” with hemi-spherical ends. The body of the American unit is smaller as it rests in the faring that this footprint provides, while the UK shape stays with the footprint and extends to a depth of 1 7/16” compared to the shallower depth of 1 5/16” for the US model (fig.5).

Fig.5 End profiles of the UK E703 (left) and US 703 (right) showing the shallower depth of the US model and its slimmer shape. The raised molding on the UK model to house the needle zeroing adjustment is also evident.

Over the production span of the E703 in the UK, minor variations in the bakelite casting around the meter are evident. Figure 6 compares variants of the British model with its US counterpart. The centre example in the photograph, which reveals the largest proportion of the meter face on the UK model, has the zeroing adjustment screw riding proud of the main bakelite body molding. The leftmost unit has the bottom part of the meter encased in bakelite and also provides a flush screw adjustment for zeroing the meter needle. This design is present in both the Surrey and Sangamo models. Figure 7 shows an alternative configuration of the US model where the meter face disk has been paired off at the bottom. It concerns only the meter assembly under the glass, with no changes in the bakelite case.

Fig.6 Variations in meter housings between two of the UK models (left and centre) and the American model (right) with its smaller meter. The UK model (centre) has a meter zero adjustment that stands proud of the top face.

Fig.7 A variation of the meter needle zeroing assembly on the US model.

The British Models in Detail

The degree of variation in different examples of the model E703 Lightometer has already been emphasised in this abstract. I have eight UK models in my collection and, whilst this is as many as I want, it is not enough to comprehensively unpick these variations, and certainly not enough to pin them to any timeline. Patent numbers are of little use here. As a whole, four patents apply to the model 703 meter (as listed on it), but these are all US registered in years: 1926, ‘27, ‘28 and ’35. The patents of the ‘20s relate to developments in train before these meters with the Photoronic cell were developed. The patent of 1935 covers the unified design of the American 703, registered at least two years after production of the model had begun.

Fig.8 Two Weston badged Surrey manufactured E703s. The workplace recommended lighting Zones are specified by text (left) and colour coded on the right hand example. On this variant, the workplace zones are listed on the back plate of the meter (right).

With the exception of one early example, which lists two of the 1920’s patents, none of the UK meters display patents. So these numbers are of little utility in arranging the British meters in date order. What can be fixed in time is the date that UK manufacturing switched from Surbiton in Surrey to the Sangamo site in Enfield: 1936. However, just one of my UK meters has been made at Enfield, but it does indicate that it is post 1936. Unlike the Surrey models, it has a letter H prefixing its 5 figure (serial?) number. This number is lower than any of the Surrey models so it can be concluded that serial numbers were not run contiguously when manufacturing switched from Surrey to Enfield.

The one feature in the British E703s that I hoped to establish as a clear development across time was the change from a raised needle zeroing adjustment to a flush mount on the bakelite meter surround. Both variants are present in the Surrey models and my single Sangamo model exhibits the flush mounting. The lowest numbered meter here, a Benjamin, has the raised zero and all of the others, the flush mount…except one! This rogue has a mid-point serial number with some flush mount examples with lower serial numbers. So that scuppers my carefully laid theory. It could be that the assembly parts and serial numbers were assigned out of synchronization, but the raised zero example is around 7,000 units (apparently) later than my earliest flush zero example.

Fig.9 Four Surrey bespoke manufactured E703 meters for (left to right) Benjamin, Better Vision, Crompton and Siemens. Each meter face displays the company's header and scale variations range from the use of lettered zones (A to E) on the far left example, Zone mark-ups on the face (centre two) or unassigned luminance values (right). In this case, recommendations are provided by Siemens on a separate card included with the meter.

The majority of the UK meters have serial numbers running in close order from pre 30,000 to the late 40'000s with one apparently much later at 70,000. The bespoke feature of the E703 manufacture has already been mentioned. Of this series, the native Weston Lightometer (figure 8) is joined by models badged for Benjamin, Better Vision, Crompton and Siemens (figure 9). The serial numbers appear to hold across these variants since none of them are prefixed with any letters that could relate to the vendor (such as a 'B' for Benjamin). It looks as though the Surbiton factory ran the serial numbers in production batch order, regardless of whose name would eventually appear on the meter face. But I could be wrong.

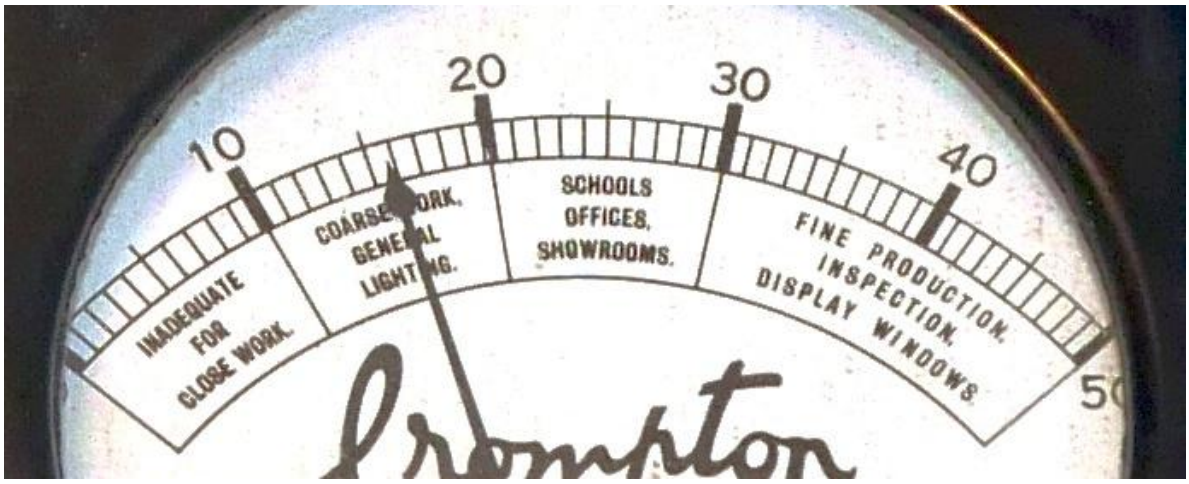

Fig.10 A close up of the Crompton meter with luminance level zones suggested for different types of work, marked up.

Recommendations for the Work Environment

One vital aspect of life in the inter-war and post-war period in Britain that these meters can help with, their contribution to the wider historic knowledge of working life in effect, relates to acceptable lighting levels for various types of work, as seen from the employer's viewpoint at least. All of the meters either have recommendations directly marked up on the meter scale as shown in the Compton close-up (figure 10), or have back plate / documented recommendations referring to lettered zones or luminance ranges (figure 11).

And a very sobering view of ‘30s attitude to acceptable lighting levels can be drawn from their analysis. I have tabulated the various classifications from the examples from my collection of UK model E703s. A PDF can be found **HERE**. It covers the Weston, Benjamin, Crompton, Better Vision and Siemens models:

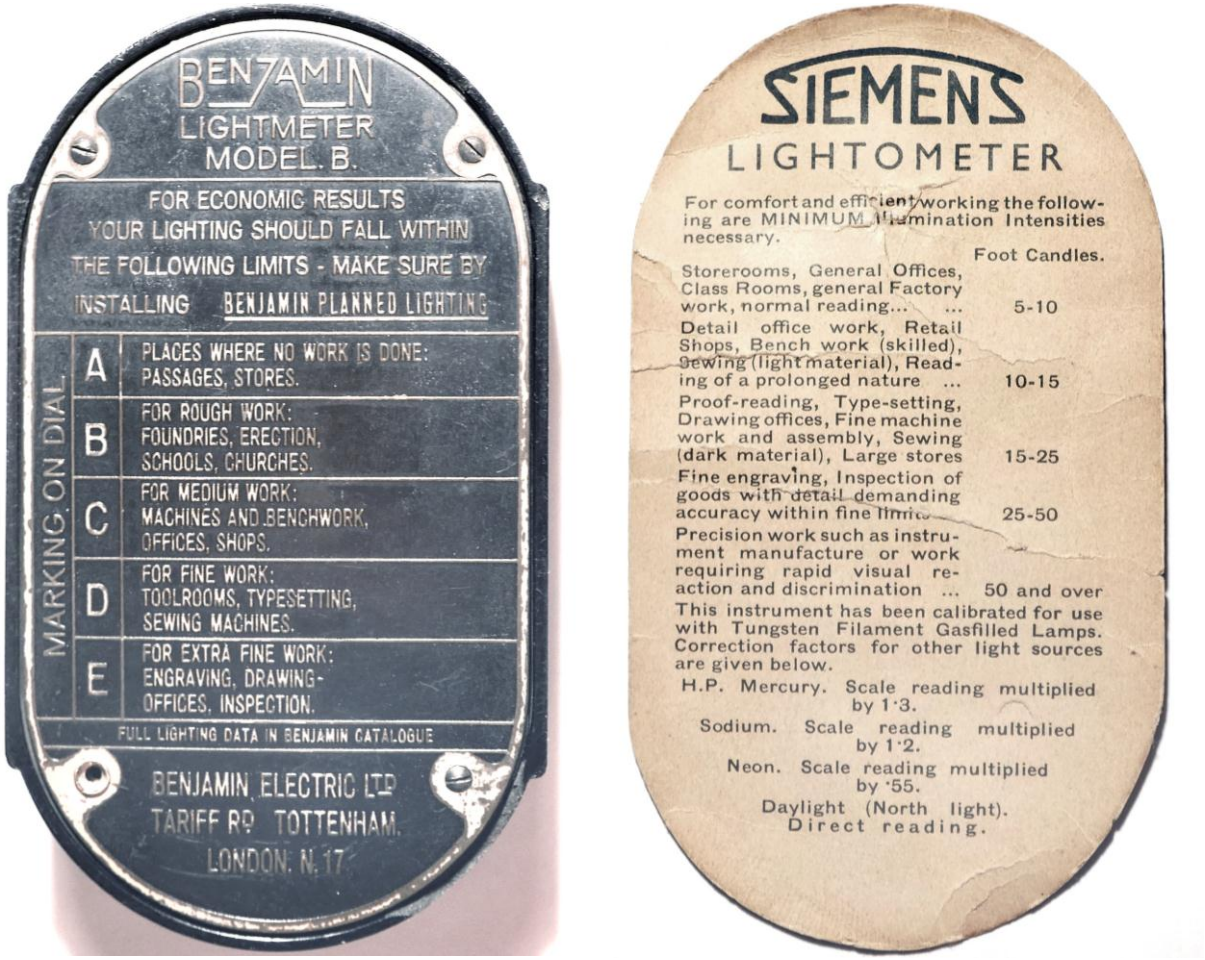

Fig.11 The back of the Benjamin meter (left) indicating the suitability of each lettered zone for specific types of work. The card insert with the Siemens meter (right) details the types of work suited to the luminance ranges indicated.

All of them agree that very low level lighting up to around 5 foot candles (fc) is inadequate for most activities except for passages and (presumably inactive) storage areas. 5 to 10fc are seen to be adequate for stairs, hallways, auditoria, warehouses, rough work and heavy industry. Benjamin seem to think it’s fine for schools / classrooms and Siemens also think it’s fine for offices and reading.

10 to 20fc is generally accepted as being acceptable for retail, classrooms (Benjamin and Siemens notwithstanding), offices, benchwork and general manufacturing. They are all in agreement for reading at this level, except for Siemens again who think this level is fine for prolonged reading, and sewing!

20 to 30fc are for drawing offices, sewing rooms (too bright for Siemens!), more accurate factory work and more detailed office work. By now Siemens think this level is more than bright enough for proof reading, typesetting and fine machine work, and are of the opinion it’s good enough for engraving, detailed quality inspection and working within fine limits. Most of the other companies think this range of activities need from 30 to 50fc.

Beyond 50fc, only Siemens and Better vision make qualifications. Better Vision put in a broad description covering severe visual work for long periods and Siemens, in this instance, make a cogent observation about instrument manufacture and work requiring rapid visual reaction and decision-making.

So, behind these recommendations and descriptions of activities, we get a snapshot of the industrial and commercial environment of the '30s. The critical relevance of lighting levels and their role in productivity and basic accident prevention seems to be understood, though why less than 10fc were thought to be adequate for a stairwell where someone can break their neck, is beyond me. Better Vision have a broader but brighter (excuse the pun) view of acceptable lighting levels whilst Siemens go in the opposite direction: One has visions of armies of Siemens gnomes beavering away by the light of a solitary flickering candle flame.

There is also an awareness of time: Time spent particularly in reading and detailed or fine work: The longer a vision dependent activity is conducted, the brighter the light needs to be. Siemens also make an interesting observation here drawing a link between brightness levels and work needing rapid reactions and discrimination (such as item-by-item quality control).

But 80 years on, the world of work has changed along with our awareness of how people respond to lighting, medical conditions (such as epilepsy), and the lighting requirements of the modern work place. We now understand that there is more to it than just the illumination level. Quality of light is important, its colour temperature for example, and levels of contrast. The importance of daylight, particularly in offices, the management of direct sunlight and especially problems of glare, are acknowledged. Strobe and fluorescent lighting have to be considered. Particularly when doing fine or visually critical work, the person's age is also a factor. Lighting considerations are no longer just about luminance levels, but centre around a broader idea of quality and comfort, accepting that lighting that's too strong or harsh can be as problematic as working with insufficient light.

And we now work with a device that wasn't even envisaged by the workers of the 1930s – the computer screen, which emits its own light. When every activity that a person did was illuminated from an external light source, and they saw by the light reflected off their work, the light meter, and the model E703 in particular, was a standard of measurement that could be relied on – even if the results were contested between the employer and the luckless worker suffering from eye strain and headaches.

But for many of us, if not all of the time, the computer screen is both the workplace *and* the source of light. For good or ill, it is what we work with and the modern office workstation needs its own set of considerations well outside the scope of this abstract.

Note: This abstract is a work in progress and will be updated.

REFERENCES:

Note: Unless otherwise stated, all photographs in this abstract are of examples from my own collection and my copyright. Where I have referred to other models of Weston exposure meter and not included a reference, documented examples are present in my own collection and appear on my website.

1) The Photo-electric Light Meter in Photography – An Illustrated History from 1931 – 1970, (Abstract) Simon A Spaans, 2015 available at: https://www.westonmeters.info/publications

2) The Photronic Photoelectric Cell: Monograph B-8. Pub. Weston Electrical Instrument Corp. New Jersey, 1935. P.31 Available at: https://www.westonmeters.info/publications

3) Grace's Guide to British Industrial History: Weston Electrical Instrument Co. Available at: https://www.gracesguide.co.uk/Weston_Electrical_Instrument_Co (accessed 10/01/21).

4) http://www.westonmeter.org.uk/703.htm (accessed 10/01/21)

5) http://www.westonmeter.org.uk/thecompany.html (accessed 10/01/21)