FULCRUM

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FULCRUM is a newsletter for collectors of antique weighing and measuring equipment and enthusiasts of historic metrology. It is published in February, May, August and November. Contributions should be sent to the Editor, John Knights.

Swinging

The pendulum is a simple device that has nonetheless, found many applications over the years. It is a well established prop of the alternative, magical, mystical and New Age. It finds use in divination, dowsing, alternative therapy, summoning diabolic beings from the abyss etc but it has also found valuable applications in more mainstream fields of enquiry.

Popular wisdom has it that Galileo noticed a lamp swinging in Pisa cathedral and this got him thinking about the properties of oscillating bodies (had I noticed a wobbly lamp in Pisa cathedral, given the non-vertical nature of the architecture in those parts, I would have been heading for the door before the roof fell in. I am however, no scientist.) The feature of an oscillating pendulum that makes it so useful, is that within limits, the period of each swing is not dependant on the magnitude of the swing or the mass of the body. The only factors affecting the rate of a small oscillation, are the length of the pendulum the force of gravity and, for some reason, the value of π which seems to stick its nose into everything (you'll gather I'm also no mathematician).

The formula for calculating the period of oscillation was devised by Christiaan Huygens, who was a scientist and a mathematician, in the 17th century. He also went on to develop its use as the principal regulating device for timepieces. Clocks were, of course already well known and had long been regulated by verges and other rudimentary oscillating mechanisms. There was, therefore a degree of empirical understanding of the properties of fluctuating bodies but full comprehension of the science had to await the age of enlightenment.

The best pendulum must be that of Léon Foucault, which beats Edgar Allen Poe's pit based apparatus into a close second place. Foucault's pendulum is certainly the most majestic, requiring the atrium of a multi story building to encompass its great length. It fluctuates with such grandeur and slowness of action that the very world turns beneath it. The large bob is observed, undisturbed by any external influence, to change direction during the relentless course of its ponderous oscillation. Thus it is demonstrated that the

earth is in fact a rotating sphere and is not frozen at the centre of some crystallised terra system.

A rather annoying problem with the pendulum as a precision instrument is actually working out how long it is. A theoretical, simple pendulum consists of a suspension cord of zero mass with a heavy spherical bob on the end whose length is readily ascertainable. In reality of course, the components of a compound or real pendulum have their own dimensions and masses, so things are not so straightforward. This issue was addressed by a gentleman called Henry Kater (not to be confused with Cato who used to hide in the cupboard and attack Inspector Clouseau) in the early part of the 19th century. Henry Kater (lower left) was a soldier and physicist who was one of those several military types who also indulged in a bit of science in those days.

(a) Opposing knife edge pivots from which pendulum is suspended
(b) Fine adjustment weight moved by adjusting screw
(c) Coarse adjustment weight clamped to rod by setscrew
(d) Bob
(e) Pointers for reading

The Kater pendulum (above) is a compound device consisting of a bar fitted with various sliding weights and two suspension points. These take the form of knife edges attached near the two ends of the bar. By adjusting the position of the sliding weights and/or the knife edges, the pendulum can be set up so that the period of oscillation is the same when the pendulum is suspended from either knife edge. When this situation is achieved the device represents a simple pendulum whose length is equal to the distance between the two suspension points which can be measured with a high degree of precision. The Kater pendulum was intended to be used as a device to calculate the value of 'g', which varies in different locations on the Earth. The idea was also posited that such a mechanism could equally become a natural reference for a standard of length when the g value was known.

At the outset of work on the metric system serious consideration was given to basing the unit of length on the dimensions of a simple pendulum beating the second, at sea level and latitude 45 degrees north. This was ultimately rejected as being practically difficult despite its theoretical simplicity and attraction as a laboratory based procedure.

A declared 'essential' requirement of any metrological system is that, in the event of calamity, it can be recreated from some inviolable constant prescribed by a higher power. This requires the existence of an immutable reference whose value is not dependant on a man-made artefact. To this end, after the rejection of the pendulum, we famously had Messieurs Delambre and Méchain trudging through France to establish the length of a meridian arc and thereby a meridian quadrant. A 10,000,000th part of the quadrant, thus devised was to be the value of the metre. The orb upon which we tread was deemed to be the most unimpeachable reference available. The Paris meridian arc had already been measured twice before so it seemed perhaps a little

extreme to embark on the exercise yet again in a time of revolutionary zeal and madness. The practical outcome of the ordeal was a 39 inch rod that turned out to be slightly inaccurate. Perhaps reliance upon an oscillating pendulum, particularly after the improvements devised by Kater, would have been somewhat preferable.

The need for re-invention became an issue in the United Kingdom, in 1834 when an over enthusiastic boiler man (delightfully called Furlong) managed to burn down the Houses of Parliament. Many Britons, much disillusioned by the political class these days, would be sanguine about such a catastrophe. Unfortunately, in 1834 the inferno did also destroy the UK's primary standards of length and mass which were immured in the building. Some 20 years passed until new standards were constructed but there was, in reality no going back to first principles.

It transpired that since 1818 the length of the yard had been referenced to that of the metre as a result of work carried out by the French astronomer François Arago and none other than Captain Henry Kater, the pendulum guy. When it came to reinventing the Imperial system therefore there were plenty of accurate physical measures kicking about to which reference could be made. Reinvention was therefore achieved in a seamless manner without anyone having to go outdoors and without anybody in the great outdoors really noticing.

They did of course take the opportunity to ditch the largely useless Troy pound and replace it with the Avoirdupois unit that everyone was actually using to buy and sell, so Mr Furlong did everybody a favour in more ways than one.

A Voyage to India: containing reflections on a voyage in 1821; By James Wallace (ship's surgeon)

My patient required a little medicine; and after I had, with no small difficulty, weighed out the different ingredients, and was just on the eve of putting past my weighing apparatus, and parcelling up my medicine, the vessel took a roll, and my cot, which was hanging up, taking one with it, struck me so forcibly that I was thrown from my seat, and away went the scales one way, and the weights another, and the paper with the medicine went off with the rest, and all my labour was to do over again. In sorrow, I ejaculated, as I lay on the floor amid the general ruin,—if a man could be in search of such a thing as misery, let him go to sea and he 'll be sure to find it: who is it, that either for curiosity, or gain, or glory, would lead such a horrible life? who is it that would not prefer the scantiest pittance on shore to the greatest affluence here?

This little item was submitted by our good friend Diana Crawforth- Hitchins and records the travails of a ship's surgeon in the early 19th century. He was trying to carry out a bit of precision weighing aboard a ship but was clearly encountering a touch of bad weather which caused things to go horribly wrong.

Weighing is but one of a number of activities which are difficult to carry out on a sea going vessel. Modern passenger ships do have stabilising devices to improve the ride so people no longer need to sleep in hammocks. I should imagine however, that playing snooker on a Cross Channel Ferry would still be a bit of a challenge.

Fifty-Fifty —The Long and the Short of it

In the last issue of Fulcrum our editor showed us images of two 50lb Avoirdupois masses, and speculated that one of these may have been a part of a forgotten scheme to decimalise the Imperial metrology system in the UK. He noted the cental, a mass of 100lb Avoirdupois, introduced in 1879, the later 50lb mass of 1903, and the 20, 10 and 5lb masses following a few years later. The Metric system was legally available as a metrological option in the UK from 1897, and it would seem that this became the preferred alternative instead of a decimalised Avoirdupois scheme.

However, sets of reference grade masses from 50lbs downwards were being made in large numbers long before any of the dates given above. I first came across these sets during my detailed research into the history of L. Oertling. I thought this was a curious finding, and investigated it a little way, until it became too far removed from the main thrust of my work. So, I can point the way forward to some extent, and I hope some other researcher will carry it much further.

In 1872, a Colonel Brunel arrived in this country from Canada, to place an order with British manufacturers to equip completely the newly-formed Standards Department of the Dominion of Canada. At this date, the only serious competitor to Oertling was De Grave Short & Fanner. The contract was not just for supplying the headquarters in Ottawa, but also all of the provincial Weights & Measures Inspectors' offices, and there were to be 100 of these. That meant hundreds of balances, from large bullion balances down to assay balances, huge numbers of weight sets of various grades, hydrometers, saccharometers, petroleometers and sets of measures both volumetric and linear, of many types. There was a strong bias in the order towards a 30″ bullion balance having a capacity of 56lbs, which was the largest weight normally needed by British W&M Inspectors, although the Canadians used a highest weight of 50lbs.

Having won the *entire* order in 1872, Ludwig had a real rush job on his hands. There was a legal requirement that the national standards of mass, length and capacity for Canada, the Dominion Standards, had to be in place by 30th June 1875, when the new Standard Weights and Measures Act of the Dominion came into force. This meant that not only did Ludwig and his men have to make the items well ahead of that date, but they also had to be Verified by our Standards Department and then shipped to Ottawa by that date. The necessary Standard balances also had to be constructed, Verified and shipped likewise. The lesser standards also had to be Verified. The upshot of all this was that the UK Standards Department was ultimately forced into working overtime, paid for by the Canadian government. The Warden of the Standards made a very pointed remark in one of his reports, noting the large amount of his officers' time this work had taken, such that paid overtime had to be used. This was not something expected within the civil service of those days.

Fortunately for us, most of the shipments are specified in the Oertling Day Book 1873—1876. The very first shipment, of seven cases, left for Ottawa on the 9th of May 1874. There followed a torrent of shipments through 1874, across 1875 and into 1876, with the rate tailing off in March 1876 when the Day Book closed. Altogether there were 428 recorded cases in 37 shipments, the total invoice value to that date being £13,939. Without the next Day Book the exact size of the Brunel order remains unknown, but with the hidden remnants tailing deeper into 1876, the *minimum* value must be some £15,000, equivalent to £1,588,000 in 2016 values. One and a half million pounds! No wonder Ludwig was so keen to capture this order!

Let us now open up a typical shipment and examine the contents, expressed in this manner in the Day Book:

22nd Sept. 1874

	Brunel Canada	
	8 balances with 30 inch	
	beam to carry 50lbs in each pan £32	£256
	8 tin lined and 8 plain cases and pking 30/-	12— 0— 0
	14 sets weights consisting of	
	50, 30, 20, 10, 5, 3, 2, 1 lbs	
£2-0-0 per set	8, 4, 2, 1 oz & 8, 4, 2, 1, ½, ½ drms	
charged extra	in deal boxes lined green baizes	18— 10—0
	1 box contained 1 wt each	
	50 & 30 lbs and the other	
O&B	20 lbs down with a small box	
36 X 48	put at the side to hold the 8, 4, 2, 1, ½, ½, drm	
	5 tin lined cases and packing 40/-	10— 0— 0
	2 sets standard measures of	
	capacity from 1 bushel down	
	to ½ gill in mahogany boxes £85—0—0	170— 0—0
	Carried to folio 233	£707— 0—0

The weight sets were completely non-standard, not the English 56lb down sets but 50lbs down as per American practice. As you can see, everything is specified in terms of Avoirdupois, decimalised. The masses were housed in cheap deal boxes instead of the usual polished mahogany. Two reasons suggest themselves: the fact that the boxes would have far to travel across an undeveloped continent and in all probability be damaged externally en route, or the rushed nature of the job meant that there was no time for time-consuming French polishing; take your pick. The reason for the £2 surcharge per set is unclear.

But why a decimalised Avoirdupois? It would seem that through exposure to the Metric system via the earlier French colonisation of North America, the Canadian and American governments decreed that their Avoirdupois systems would take the hundredweight (cwt) as 100lb and the ton as 2,000lb, the Short Ton, as a more logical and rational manner of measurement. So, the 50lb mass is simply half a cwt, in contrast to our 56lb, half of a cwt of 112lbs, from the Long Ton of 2,240lbs. Why they used the

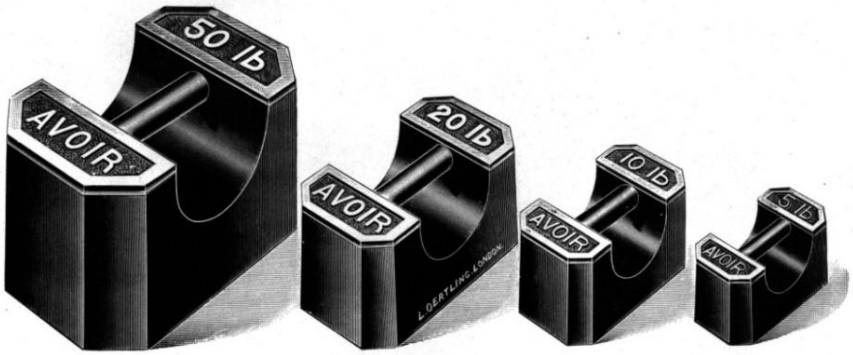
5-3-2-1 sequence is less clear. The Dominion of Canada adopted the Metric system as standard in 1871 and the decimalised Avoirdupois system in 1873.
What form did these masses take? The only photos I have found of the actual masses in Canada were of knobbed cylinders of 20lb and below, but I suspect these were of the lesser Standards, and the smaller masses, under 5lb, would have taken this form anyway. The Oertling catalogue page, below, shows that the larger masses of decimal Avoirdupois standards were of the brick form with inserted lifting bar, but with the corners chamfered to create an octagonal outline, matching the Avery trade mass in the May Fulcrum. The short set (telegraphic code word ASSETS), of 50/20/10/5lbs was supplied in the UK in the conventional French polished mahogany box, but no surviving set has yet come to my notice, either here or in Canada.
In summary, the total number of Oertling weight sets exported 1874 to 1876 in the Brunel order is in excess of 377, of all sizes and types. There was a strong bias to large, full sets, not only of decimal Avoirdupois, but Metric, Grains and Troy Ounces as well. I hope someone will pick up this baton and run with it, confirming and extending the above. It may lead into interesting areas.

Barry J. Oliver

L. OERTLING,

Standard Brass Weights

(As supplied to the Standards Dept.)



Code Word ... ... ASSETS.

Weights of Brass, fitted in Polished Mahogany Box.

Prices on application.

TURNMILL STREET, LONDON, E.C.