

THE ORIGINS OF THE GAUGE SYSTEM FOR MEDICAL EQUIPMENT

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□ Abstract—The gauge system for sizing medical catheters and equipment is used widely around the world. Yet both its origins and its interpretation, in terms of conventional measurements, have long been obscure. The gauge, formally known as the Stubs Iron Wire Gauge, was developed in early 19th century England. Developed initially for use in wire manufacture, each gauge size arbitrarily correlates to multiples of .0010 inches. This sizing system was the first wire gauge recognized as a standard by any country (Great Britain, 1884). It was first used to measure needle sizes in the early 20th century. Today it is used in medicine to measure not only needles, but also catheters and suture wires. However, owing to the potential confusion inherent in using a gauge system, the iron wire gauge is rarely used in manufacture of nonmedical equipment.

☐ **Keywords**—gauge; Catheters; needles; wire; Stubs Iron Wire Gauge; Birmingham gauge

The gauge system for sizing medical catheters and equipment is used widely around the world. Yet both its origins and its interpretation, in terms of more conventional measurements, have long been obscure.

In 1802, Europe was preparing for an-

other of the Napoleonic wars and England was in the throes of the early industrial revolution. Peter Stubs found this a propitious time to take a step that would influence medicine for most of the 20th century. He founded a business that was to become the Stubs Iron Works.

Starting as a file maker at the early age of 20, Peter Stubs of Warrington, England, later became a brewer and malt maker. He had the vision to organize the production and distribution of tools made in the traditional cottage industry of the southwest Lancashire region. Unlike most of his contemporaries, he attempted to harness the cottage industries rather than supplant them. About 1800, Stubs decided to concentrate on the production of tools both for sawyers and watch and clock makers. To this end, he built a workshop in 1802.¹

Never a manufacturer of medical equipment, the Stubs firm was originally set up to manufacture files. Later they also manufactured nails, pins, and wire. After Peter Stubs "the founder" died, his sons William and Joseph took over the guidance of the firm.

In the middle of the 19th century, the

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firm developed the Birmingham or Stubs Iron (Wire) Gauge (Table 1). This improved their efficiency by providing better product uniformity and better control of quality in their manufacture of iron products.

The first mention of the Stubs Iron Wire Gauge was in 1808, when it was referred to as a file gauge, presumably designed to regularize the sizes of watch and clock files. The gauge was also designed to check the consistency of the holes used for drawing iron wire during the extrusion method of manufacture. It was used, as well, to check the subsequent product. The drawing of the various types of wire (round steel wire, pinion wire, triangular wire, dove-tail, and click wire) in the early part of the 19th century was an accomplishment of considerable technical craftsmanship. The first English draw-plates (also known as werdels or wortels) appeared to have been made, to Stubs' specifications, in the Prescot area early in the 19th century both by the Hornby and the Finch Companies. Earlier supplies probably came from mainland Europe. After initial failures, Stubs built up a reputation for the use of these draw-plates.¹

From time to time gauges were developed by other firms. It was natural that confusion would arise and lead to the wrong size of material being supplied. But, while other firms developed gauging systems with totally arbitrary measurements, the Stubs gauge was the first one based upon an existing, accepted standard of measurement—the inch.¹

With 41 divisions (in its modern form), ranging from .0040 inches (36 gauge) to .5000 inches (5/0 gauge), the system uses whole numbers to designate specific measurements (Table 1).² The increment in these measurements, based on the specific needs of the 19th century iron wire industry, is in arbitrary multiples of .0010 inches. The intervals range from .0010 inches to .0460 inches. Larger intervals, in general, are between the larger sizes. But the intervals do not consistently increase. In fact, there appears to be no logic to the

Table 1. The Birmingham or Stubs Iron Wire Gauge

Gauge #	Inch	Gauge #	Inch
36	.0040	15	.0720
35	.0050	14	.0830
34	.0070	13	.0950
33	.0080	12	.1090
32	.0090	11	.1200
31	.0100	10	.1340
30	.0120	9	.1480
29	.0130	8	.1650
28	.0140	7	.1800
27	.0160	6	.2030
26	.0180	5	.2200
25	.0200	4	.2380
24	.0220	3	.2590
23	.0250	2	.2840
22	.0280	1	.3000
21	.0320	1/0	.3400
20	.0350	2/0	.3800
19	.0420	3/0	.4250
18	.0490	4/0	.4540
17	.0580	5/0	.5000
16	.0650		

size of the intervals between any two gauge sizes.³ Nevertheless, the development of a method for sizing wires based upon the recognized foot-pound-second measurement system was a significant step in the progress of industrialization. It also aided the development of uniform, standardized manufactured products.

As Stubs was from Warrington, his most popular gauge was often called the Warrington Wire Gauge, but it was also known as the Peter Stubs Gauge. (In Great Britain, the Peter Stubs Gauge and the Birmingham Wire Gauge are considered to be identical.) The first attempt at reform in gauges was to list the equivalent of the gauge numbers in decimals of an inch. This was done first individually by the Stubs firm, and later, in 1883, by organized action of the British Board of Trade. In that year a gauge, identical to the Stubs Iron Wire Gauge, was prepared which was intended as a standard for both wire and sheets metal. (It was later found to be unsuitable for sheets.) This gauge became Great Britain's legal standard gauge on March 1, 1884. It became known as the British Imperial Standard Wire Gauge—designated in the British

Empire by the initials W.G. or B.W.G., and in the United States by the initials I.S.W.G. or S.W.G.² This was the first wire-sizing system recognized as a standard by any government. It was also later recognized by the United States Congress as an official wire-gauging system. No other system has ever been so recognized.⁴

Subsequently, several other systems have also been recognized as standards for sizing wire. These include the Stubs Steel Wire Gauge, the American, or Brown and Sharpe Gauge, and the Washburn and Moen (American Steel and Wire Company or Roebling) Gauge.

At one time the Stubs Iron Wire Gauge was also used to specify the wall thickness of the following classes of tubing: seamless brass, seamless copper, seamless steel and aluminum. The Brown and Sharpe Wire Gauge was used for brazed brass and brazed copper tubing, but has now been replaced by specifications directly indicated in decimal parts of an inch.⁴

The Stubs Iron Wire Gauge was first used to measure commercial needle sizes for intravenous fluid injection in the early 20th century. The first firm in the United States to make medical hollow needles was the Randall Becton Company of Boston, later called the Randall-Faichney Company. They were the first, in 1913, to use the gauge system in commercial medical needle manufacture.⁵ This was soon after commercial equipment for intravenous fluid therapy became available. But, at that time, manufacturers did not make seamless tubing. The method of manufacture used was to bend very thin strips of carbon tube, force it around a mandrel, hammer the edges as close as possible, and then draw it through a small hole until it reached the desired outside diameter. It was quite a crude process. Only a relatively small amount of tubing resisted

fluid leaks and could be used. Eventually the steel mills produced seamless tubes, first in carbon steel and then in the 1920s in stainless steel.

The use of the Stubs Iron Wire Gauge soon became widespread in the manufacture of medical equipment. Used today for medical needles, catheters, and suture wires, the Stub's gauging system has gained world-wide acceptance for the measurements of smaller size cylindrical medical devices.

In other than medical equipment, the decimal system of indicating sizes is now being used quite generally and gauge numbers are gradually being discarded. Because of the considerable danger of confusion in the use of gauge numbers in both foreign and domestic trade, which can be avoided by specifying thickness or diameter in inches or millimeters, absolute units are gaining favor for the specification of wire sizes. Unfortunately, where gauging is still used, there is considerable variation in the use of different gauges.^{3,4} Standard steel industry manuals state that the earlier English gauges, Birmingham Wire Gauge and Stubs Warrington Gauge, are no longer in common use except in telephone and telegraph wire.²

From the autumn of 1801, Peter Stubs was a sick man. Prescriptions from his physician, Dr Pemberton, suggest that his illness was connected with the throat and lungs. He obtained no improvement from visits to mineral springs in Buxton. He died on February 28, 1806.⁶

The original iron works that Peter Stubs founded at the turn of the century no longer exists. Yet the influence of the gauge system developed by the company he started continues to pervade medical practice in every setting and every location into the last part of the 20th century.

REFERENCES

1. Dane ES: *Peter Stubs and the Lancashire Hand Tool Industry*. Altrincham, GB, John Sherratt and Son Ltd, 1973.
2. McGannon HE (ed): *The Making, Shaping, and Treating of Steel*, ed 8, United States Steel, Pittsburgh PA, 1964, pp 1193-1198.

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3. Baumeister T, Avallone EA, Baumeister T, III: *Marks' Standard Handbook for Mechanical Engineers*, ed 8, New York, McGraw-Hill, 1978, pp 642-645.
 4. Oberg E, Jones FD, Horton HL: *Machinery's Handbook*, ed 20. New York, Industrial Press Inc, 1976, p 471.
 5. Randall-Faichney Company: *Catalog of Surgical Equipment*, Boston, 1913.
 6. Ashton TS: *An Eighteenth-Century Industrialist: Peter Stubs of Warrington*. Manchester, England, Manchester University Press, 1939.