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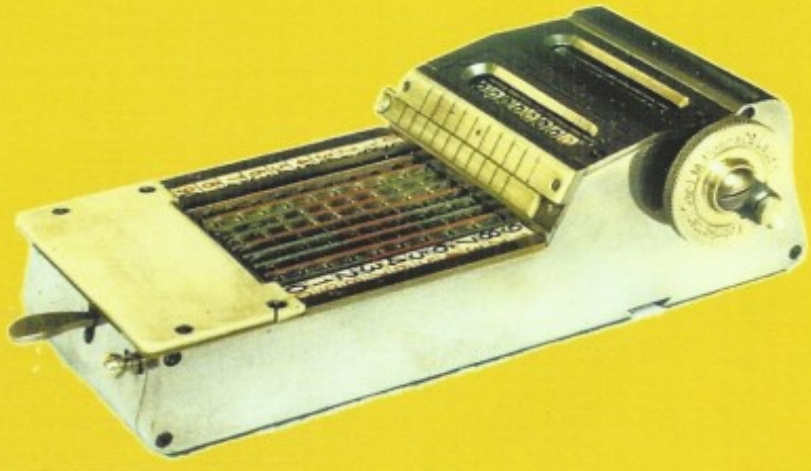
English translation of the article

„Büros brauchen Qualitätspapiere“ (Offices need Quality Papers)

by Detlef Zerfowski



Papier im Büro - Kettenaddierer von Goldman und Behr - ABC-Schreib– und Addiermaschinen - Röthers Rechenscheibe

Offices need Quality Papers

Detlef Zerfowski, Steinheim-Kleinbottwar

Paper - a common item in every day office life – very often not valued and carelessly thrown away. A closer look shows, that there is much more behind this product than you might think. I only gained this insight after I bought a bundle of technical devices on ebay some time ago. From the convolute I was only interested in a planimeter. When I opened the package, among other things, I found a device that at first glance looked like an unusual stapler or punch with an analog display. A first investigation revealed that it was a paper tester from Minden Paper Gauge Company (formerly Ashcroft Manufacturing Company). This was the trigger for this article. Who and why needed such a device? After short research one realizes the fact that there are a huge number of different types of paper for the most diverse applications. Besides packaging papers and cartons, sanitary papers, technical papers (e.g., filter papers), specialty papers (e.g., banknotes), there are of course also printing and writing papers without which everyday office life (especially before the time of the paperless office) is not possible.

But even in the office, different paper types and qualities are used. So there are paper of different weight, color, roughness, etc., suitable for short-term documentation, long-term archiving, high quality stationery for external communication and many, many more. This resulted in quality testing procedures in the paper industry.

1. Quality testing procedures for paper and cardboard

In 1915, 30 paper manufacturers founded a technical branch of the American Paper & Pulp Association (APPA) as an exchange platform for manufacturing aspects of the paper industry. In less than a year, the TAPPI (Technical Association of the Pulp and Paper Industry) was created, which still exists today and sets quality standards for the paper industry. The different types of paper and cardboard must meet different quality requirements according to their purpose. To ensure this, there are a large number of different test methods. For example, TAPPI [Tap2018] alone lists several hundred (!) different test methods for papers, cardboards, and cartons. In addition, there are also partially overlapping ISO standards, such as DIN EN ISO 2758: 2014 'Paper - Determination of Bursting Strength' (see [Din2014]). Some other examples of such quality characteristics (indicating the TAPPI test standards) are:

TAPPI number	quality requirement
T403	bursting strength
T410	paper weight
T411	paper thickness
T412	moisture content
T414	tensile strenghtopacity
T425	opacity
T441	Water absorption capacity
T535	bending stiffness
T830	ink abrasion
etc.	etc.

2. Bursting strength according to Mullen

One of the most important paper and board test methods mentioned above is the burst strength test according to the method of John W. Mullen, who himself was a papermaker and a member of the management of Crocker Manufacturing Co. His test method, or the associated test apparatus was patented as U.S. Patent number 358056 [Mul1886p] on February 22, 1887 and introduced as early as 1907 in the US as a standard test procedure. For this reason corresponding test devices are called Mullen testers.

The test is a toughness test or strength test of materials. The bursting pressure refers to the resistance of a paper sample against a uniformly increasing pressure until the sample bursts. There are essentially two types with which the pressure is applied to an circularly clamped paper sample:

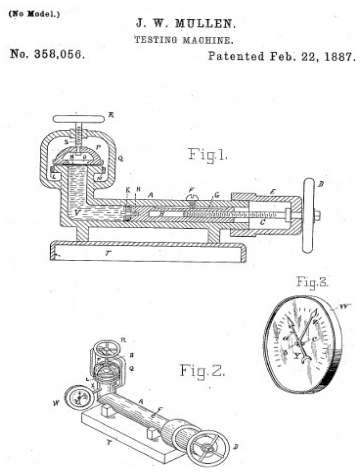

(No Model.)
J. W. MULLEN.
TESTING MACHINE.
No. 358,056. Patented Feb. 22, 1887.
Fig.1.
Fig.3.
Fig.2.

Figure 1: Mullen US Patent 358056 of February 22, 1887 [Mul1886p].

1. A rubber membrane lying under the paper sample is pressed by means of a liquid or air against the paper, or

2. a stamp, clamped by a spring, or a bolt pierces the sample.

The tester invented by John W. Mullen belongs to the first category. For this purpose, a material sample is fixed on the underlying support by means of the horizontal wheel (in Figure 1, the wheel K). The carrier has a central opening with a rubber membrane. Below the membrane a piston is mounted, into which liquid is pressed by the vertical handwheel. As a result the membrane bulges upward. At a correspondingly high pressure, the paper sample clamped above the membrane bursts. The maximum available pressure is shown in the display and gives the measure of the bursting strength of the sample. Because the Mullen tester worked with a pressurized fluid, damaging the rubber membrane could cause significant job contamination.

After the invention of the Mullen tester, other competitors entered the market with improvements introduced to the test apparatus. In the 1920s, the Schopper-Dalén testers from the Leipzig company Louis Schopper spread into the market (Figure 3). Compared to the original Mullen tester, the Schopper-Dalén tester built the pressure not with a liquid but with compressed air [Gri1998]. In the case of the not too rare bursting of the rubber membrane, this had the advantage that the tester did not have to be soiled and cleaned from spraying liquids. However, due to the size of the device and the use of a compressor, it was more of a stationary inspection device that was suitable for paper production and less for the office or for business travel. Further examples of competition in the paper tester market are the devices of Rhese [Her1907], Southworth [Sin1906], Eddy [BacSin1912], Edwards [Mad1909], Ashcroft Mfg. Co. (New York) and many more.

Figure 2: Mullen-Tester ca. 1901 (Source: https://www.thehenryford.org/collections-and-research/digital-collections/artifact/172160/)

3. Ashcroft Paper Tester

Figure 3: Schopper-Dalén Tester with air compressor [BurKor1944].

The later tester from Ashcroft (the trigger for this article) belongs to the second category mentioned above. The pressure on the sample material is transmitted by a spring with a stamp. On 5th July 1912, Blanchard, Crocker[1] and Eddy filed a patent for the Ashcroft Manufacturing Company. On 31st Dec. 1912 the U.S. Patent No. 1048488 [BlaCroEdd1912p] was granted and the corresponding device has been marketed for several

1 Possibly there is a link to the company Crocker Manufacturing Co.,where John W. Muller has been a superintendant [Ame2014].

decades. Early devices carry the words "PAT APPD. FOR" [Ame2014], indicating the year of manufacture 1912 (time between filing and granting of patent). Later devices indicate the date when the patent has been granted. Later (presumably from 1923[2]), the tester with the manufacturer's designation "Consolidated Ashcroft Hancock Co., Inc., Bridgeport Conn. U.S.A." has been marketed. In the mid-1940s, Ashcroft's paper tester went to the Minden Paper Gauge Company. Until 1948, the paper testers were made under the name Minden Paper Tester with the note "formerly Ashcroft" (see Figure 5).

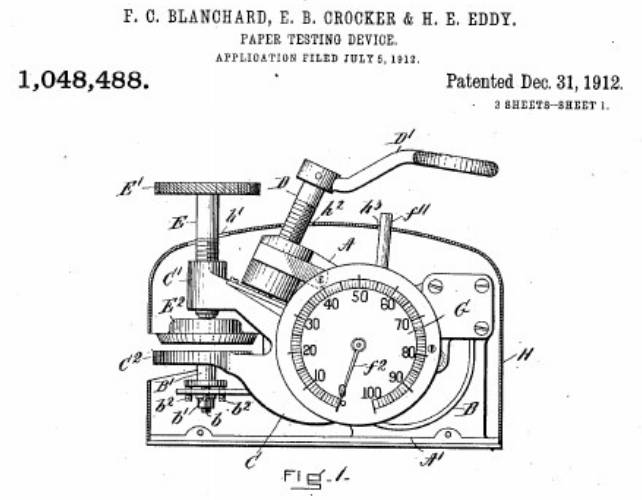

F. C. BLANCHARD, E. B. CROCKER & H. E. EDDY.
PAPER TESTING DEVICE.
APPLICATION FILED JULY 5, 1912.
1,048,488. Patented Dec. 31, 1912.
3 SHEETS—SHEET 1.

Figure 4: Ashcroft paper tester patent from 1912 [BlaCroEdd1912p].

Figure 5: Paper tester (serial number 9214) from the 1940s, at that time already called Minden Paper Tester.

At its launch in 1912, the paper tester was comparatively cheap and cost $20 [In1912]. Today, adjusted for inflation, this is approximately $507 (calculated using [CPI2018]). In 1920, it was offered much cheaper at $25 in the Ashcroft Catalog [Ash1920][3]. The device was marketed in several variants, characterized by the maximum measurable bursting pressure:

- 20 psi (pound per square inch) for thin paper such as newsprint,
- 140 PSI for normal paper,
- 10 kg/cm^2 (corresponds to about 142 PSI for the European market).

Another variance is the hand crank, which was designed either as a fixed crank (Figure 5) or as a crank with a joint [Ash1920], so that the crank could be placed on the device, stored in a space-saving storage box. The period in which the crank variants were made is unclear. There are Ashcroft variants with or without a crank joint, while Minden Paper Tester so far has only been seen with fixed cranks. Furthermore, the testers were supplied with different, separately sold storage boxes.

Little is known about the serial number of Ashcroft paper testers. Even at auctions, serial numbers are given only very rarely, since the providers are little or not at all familiar with the device. To ensure stable operation of the unit, the foot must be unlocked using a button located below the device, then rotated by 90 degrees (Figure 6). Only then the serial number can be seen inside the device. Currently the following serial numbers are known[4]:

Serial no.	3246	4164	9214
Maximal pressure	140 psi	10 kg/cm^2	140 psi
Maker	Ashcroft Mfg. Co.	Ashcroft Mfg. Co.	Minden Paper Gauge Co.
Crank	with joint	fixed crank	fixed crank

2 There are patent applications by Ashcroft Mfg. Co until 1921, from 1923 by Consolidated Ashcroft Hancock Co., Inc. Furthermore Ashcroft Mfg. Co. advertised for paper tester until 1923.

3 In the USA, from beginning 1913 until end 1919 prices increased by about 75%. Taking the price at market entry of $20 at beginning 1913, the inflation corrected price by end of 1919 would have been around $35.Therefore the price of $20 for the paper tester in 1920 was already nearly 30% cheaper compared to market entry.

4 Please send photos (including serial numbers) of additionally known devices to Detlef@Zerfowski.com

Assuming that the serial numbers have been incremented throughout the production and the present serial number 9214 from the last years of production, one can assume that a maximum of almost 10,000 of these paper testers have been manufactured.

The handling of the portable device is very simple. After the tester's foot has been unlocked and rotated for a stable stand, put the paper to be tested on the disc (see Figure 4 the disc C^2). With the wheel E^1, the clamp E^2 is turned down onto the paper, thus fixing and firmly clamping the paper. Subsequently, with the hand crank D^1, the bolt B^1 is driven from below against the paper. With the further rotation of the crank, the pressure against the paper increases continuously, which is visible in the display.

Figure 6: Tester (serial number 4164) with unlocked foot. The 80g printer paper bursts at just under 1.4 kg / cm².

As soon as the paper breaks, the pressure on the bolt drops immediately. However, the pressure gauge remains at the highest pressure value so far, so that the measured value can be read. Before the next measurement, the pressure display is reset to zero. Compared to the paper testers described earlier, the advantage of the Ashcroft Tester is immediately visible: It is small, handy and therefore suitable for business trips, clean and requires low-maintenance and no compressed air.

4. Mullen Tests Today

The bursting strength of paper is highly dependent on the materials used in paper making. For example, a high proportion of recycled paper[5] as raw material has a negative effect on the paper strength. This is due to the fact that during the manufacturing process, the fibers of the recycled paper are getting more and more damaged and reduced in size. Shorter fiber length reduces the strength of the paper. This is an example of why paper tests are needed in the industry. The fact that the Mullen test method is not limited to paper and paper-like products is shown in the 1966 technical report Army Aviation Maintenance Engineering Manual Shop Practices [Arm1966]. There it is described that fabric-like clothing of aircraft must be checked regularly for their suitability for flight by means of Mullen tests.

Figure 7: Modern Mullen tester with graphical display and statistical evaluation [Fra2018].

Even today, the Mullen test method is widely used. Searching the internet for the term "Mullen tester", one receives many hits for suppliers of test equipment, as well as laboratories, which provide corresponding tests as a service, which proves the relevance of the Mullen test even today.

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5 At Europe the paper recycling rate is about 75%.
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