The History of Mechanical Testing

Rockwell Hardness Testing
Stanley P. Rockwell, Charles H. Wilson, and the Wilson Instruments Co.
This presentation is about

The inventor - Stanley P. Rockwell

and

The developer - Charles H. Wilson
Credits

Most of the information for this presentation came from the following sources-

- An article titled *Hardness, Bearings, and The Rockwells*, written by Richard E. Chinn of the National Energy Technology Laboratory, Albany, Oregon published in the October 2009 issue of Advanced Materials and Processes magazine.

Stanley Prichard Rockwell
(1886 – 1940)

- Stanley P. Rockwell was born in New Britain CT. in 1886.
- He earned his degree from the Sheffield Scientific School of Yale University.
- In 1914 he worked as a testing engineer and metallurgist for the New Departure Mfg. Company in Bristol CT.
At that time New Departure not only made ball bearings for autos but full autos as well. One of their best known products was the coaster brake used on bicycles that many of us (old folks) used growing up.

While at New Departure, Stanley worked with Hugh M. Rockwell. I first assumed them to be brothers, however, they apparently were not closely related if at all.

Hugh was an avid aviator and automobile enthusiast. He eventually followed his other interests while Stanley stayed with metallurgy.
The two Rockwell's spent a lot of their time together trying to determine the hardness of bearing races. The only tests at the time were Brinell, Scleroscope and the file test.

- The Brinell test was very slow, and not suitable for small radius curved surfaces and hardened steel. Plus the indent was way too large to be non destructive.

- The Scleroscope test was suitable for hardened bearing steels but it was very difficult to use and hard to get repeatable results.

- The file test was useful but only as a go/no go test.
The differential depth hardness measurement was first described in Vienna in 1908 by Ludwig in his book *Die Kegelprobe* as a cone impression test. The method was proposed to be useful in eliminating mechanical errors and surface roughness limitations.

*It is not known if the Rockwells were aware of this book, however, they were apparently the first to develop a working application of the method.*
Stanley P. Rockwell

Stanley and Hugh Rockwell worked long and hard to arrive at the basic principle of using both a minor and major load in measuring indentation hardness. They filed for a patent on July 15, 1914.

The first patent, no 1294171 was granted on Feb.11, 1919.
Stanley and Hugh Rockwell’s original patent
Both Rockwells left New Departure before the patent was issued.

During WW1 Stanley served as a captain in the Army ordinance department.

After the war Stanley Rockwell became the works manager and metallurgist for a company called Weeks and Hoffman in Syracuse NY.

At Weeks and Hoffman, he improved the design of the tester and applied for a second patent in Sept. 1919.
Stanley P. Rockwell

- In 1923 Stanley Rockwell started his own business in Hartford CT. called the New England Heat Treating Service Co..

- The name was changed to the *Stanley P. Rockwell Company* in 1924. That company still exists today.

- Rockwell was a creative engineer who was always looking for a practical solution to a problem. He was a great believer in the trial by error method and was known as a shop-man. He also was known to have had a keen sense of humor.
In 1922 Rockwell presented a landmark paper on his tester during the American Society for Steel treating convention in Indianapolis IN. (ASST became what is now ASM in 1933)

In addition to Rockwell he was granted other patents. The most notable for a device called a Dilatometer. It is used to measure the thermal expansion of steel. This was a large project that took more of his time than even the Rockwell tester.
Stanley continued to develop the Rockwell tester by adding a dashpot to control the rate of loading.

He applied for a third patent in May 1921

On Nov. 18, 1924 Rockwell was awarded two additional patents for the tester, no. 1516207 and 1516208.
This is a picture of an early model tester built by Stanley Rockwell to test more than just bearing races.
In 1939 Stanley Rockwell was awarded the fifth Albert Sauveur Achievement Award by ASM.

The prestigious Sauveur award -
“recognizes pioneering materials science and engineering achievements that have stimulated organized work along similar lines to such extent that a marked basic advance has been made in the knowledge of materials science and engineering”
The Stanley P. Rockwell Co. provided heat treating services and sold furnaces made by the American Gas Furnace Co. and GE.

In addition they also sold process instruments made by The Wilson-Maeulen Co.
Charles H. Wilson

- Charles Wilson was an instrument salesman for the Wilson-Maeulen Co. based in NY city. The Stanley P. Rockwell Company was one of his customers.

- In 1920 Wilson saw one to the first 10 machines that Rockwell built and realized the potential of the tester for shop testing as well as laboratories and research facilities.

- Wilson quickly worked a deal with Rockwell to take over the development, manufacture and, sales of the Rockwell tester.
Charles H. Wilson

In Stanley Rockwell's words, it was Wilson who -

“brought it to the attention of the public, sold it to those who needed it, and thus created the business and employment”
Charles H. Wilson

During the 1920’s Wilson made several significant improvements to the Rockwell Test and Tester.

- Wilson reversed the scale so that harder measurements were higher numbers than soft measurements. This logical change made the Rockwell results like Brinell and Scleroscope results. The original scale went from 100 to 0.

- Wilson recognized the importance of controlling the minor load (to that point called initial pressure). He standardized on 10 kg and made sure it was carefully controlled to establish a solid reference point.
The original major load was 100kg and the original indenter was a 1/16 diameter hardened steel ball.

The steel ball did not work at all on hardened steel. Rockwell purposely flattened the balls to prevent further deformation of the ball so he could test the hard bearing races. This turned out not to be ideal since small differences in hardness could not be detected with the flattened ball.
In 1924 Wilson made two major changes to resolve the problem.

- He developed the diamond Brale indenter for testing hardened steel. After much experimentation he standardized on a diamond cone of 120 deg angle with a 2 micron radius tip tangent to the cone. On Feb. 2, 1926 Wilson received a patent on his diamond Brale indenter.

- He changed the major load from 100kg to 150kg.

The HRC scale was born
Charles Wilson’s diamond indenter patent
Charles H. Wilson

- There was a problem when testing soft brass. The 100kg major load resulted in negative readings on materials below B30. To solve the problem, Wilson increased the starting scale from 100 to 130. This gave positive readings on soft materials and good sensitivity on hard brass.

  The HRB scale was born

- In on June 10, 1930 Wilson was granted his own patent no. 1762497.
- In 1932 the superficial scales were developed by Wilson to test thinner materials.

  The Rockwell test as we know it today was created.
Wilson's tester patent
The first Rockwell standards, ASTM E18.32T and BSI #891:1940 were really only directions on how to use the tester to get good results and did not contain a complete definition of the Rockwell hardness test.

For example:
- There was no defined test cycle.
- There were no tolerances on the test loads.
- There was no information on how to calculate the Rockwell number from the depth measurement.

How times have changed!!!!
ASTM E18-32T was a Tentative Method under the control of -

The Section on Indentation Hardness Testing of Committee E-1 on Methods of Testing.

The Tentative Standards were published for purpose of eliciting criticisms and suggestions and as such were subject to annual revision.

The earliest version of E18 we could find without the Tentative title was E18-36.
Charles H. Wilson

With the success of the Rockwell tester the Wilson-Maeulen Co. name was changed to -

Wilson Mechanical Instruments Co.

later shortened to -

Wilson Instruments Co.
Wilson Instruments

During WW2 production boomed. Wilson built Rockwell testers in the US and the UK. Export orders were frequently place by coded telegraph messages. For example an order for 40 bushels of potatoes may have been used to indicate an order for 40 4JR testers.

Approximately 600 Rockwell testers were shipped to Russia.

After the war Wilson thought they had saturated the market so they sold the business to American Chain and Cable Co. (ACCO) located in Bridgeport CT.

Wilson manufacturing was immediately moved from NY to Bridgeport CT. The sales offices, which were located at 230 Park Ave. in NY City, were moved to Bridgeport in 1970.

In spite of the large number of testers built during the war, the Rockwell business continued to grow under ACCO’s ownership.

In 1988 Wilson Instruments was sold and since 1993 has been a part of Instron Corp. in Norwood MA.
Miscellaneous

- Stanley Rockwell died tragically in August of 1940, at the age of 54, when his 50ft yacht Chin-Chin exploded on the Connecticut river. He was an experienced sailor and alone on the boat at the time. The cause of the explosion was never officially determined.

- The original Wilson-Maeulen products were sold to the Foxboro Co. in Foxboro MA in 1930. Foxboro is only 15 miles from Instron the current location of Wilson Instruments.
A Wilson catalog from the late 1920’s
The inside still shows the Wilson-Maeulen name
The Rockwell Hardness Tester

Model 2-K

This is the smallest size made and will test flat or round stock up to a full 2" in thickness.

Model 3-H

The most suitable size for general use

Tests work up to 8" in thickness.

Prices and Capacities

These prices are strictly net f.o.b. factory, New York—Terms, 30 days

Model 2-K 2 1/2-H 3-H 4-H 5-H
Net weight 90 lbs. 105 lbs. 115 lbs. 125 lbs. 140 lbs.
Test pieces of thickness up to 2" 4" 8" 12" 16"
Tests inward from edge of piece 3" 1/2" 1/2" 1/2" 1/2"
Price, including 1/16" ball B penetrator, B and C test blocks, anvils and cover... $25.00 $25.00 $30.00 $35.00 $40.00

The Conical Diamond BRALE is here listed separately and not included in the price of the Tester because those who buy the machine for testing only soft metal do not need the BRALE. (See page 3.)

Additional for BRALE (which is the diamond penetrator required for hard steel and the same for all sizes of the tester) $39.95

Additional for 8" diameter iron testing table usable on all sizes, 2 1/2 or taller of new or older models of tester 15.00

Additional for V anvil No. 130, 3" diameter, 130° V for holding round stock up to 5" diameter 11.00

Warranty

Our warranty of products made or sold by us is limited to an agreement to repair or replace at our factory, without charge, any instrument or part found defective within one year from date of delivery to the original purchaser, while diamond penetrators, because of the natural brittleness of diamond, are not even subject to such replacement unless returned unused, and no further warranty, express or implied, or obligation of any kind, contractual or otherwise, will be assumed by us, either to the original purchaser or any other person. No agent or representative is authorized to assume for us any liability except as set forth above.

Shipment

Our experience in shipping precision instruments has shown that it is best to ship by express and, if our warranty above is to apply, this Rockwell Hardness Tester must be shipped by this method.

The Rockwell Hardness Tester is a micrometer measuring instrument which is capable of injury if not properly and speedily cared for in transportation.

The excess of express charge over combined cost of freight and trucking is low in proportion to the cost of the instrument and is negligible when the value of the work to be done by the tester is considered, for in its accuracy lies its whole value.

Spares and Renewals for All Sizes

Additional B test blocks for checking on B scale... each $ 1.00
Additional C test blocks for checking on C scale... each 1.00
Additional 1/16" steel balls for testing on B scale... per hundred 2.00
Additional chucks for holding steel balls... each 4.50
Exchange of old or damaged BRALEs for new ones... 21.00 - 21.75