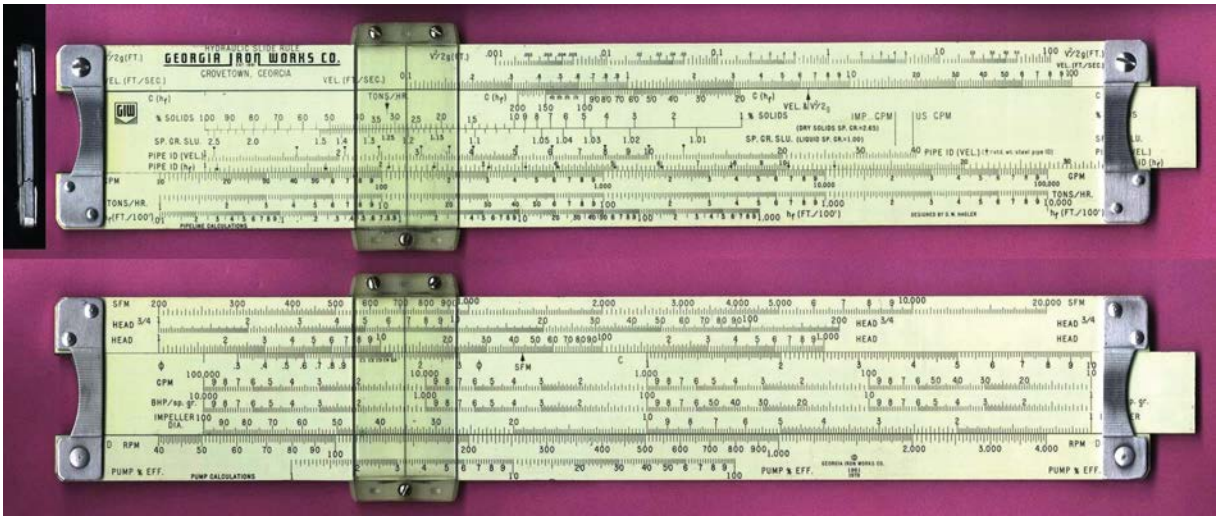
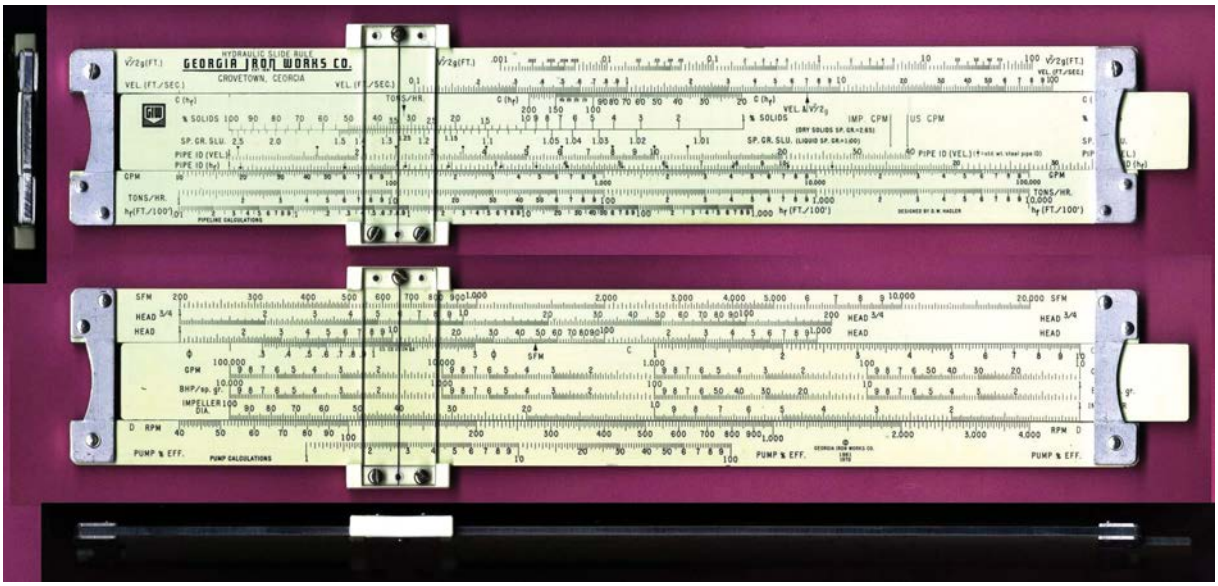
Developing the Georgia Iron Works Hydraulic Slide Rule - Negotiating with Pickett & Eckel to Make a Special Slide Rule

Michael V. Konshak

These are particularly interesting specimens that I was able to obtain. Not only did I get the slide rule and other artifacts, but also I was able to get first-hand information on the development of the slide rule directly from the designer, Danforth (Dan) W. Hagler, Dan's father, Thomas W. Hagler, and uncle John Carroll Hagler, Jr., who operated Georgia Iron Works (later GIW Industries) in Augusta, Georgia starting in 1947.

The company was originally founded by Henry Perkins in 1891 and became GIW in 1892. In 1955, Thomas W. Hagler Jr., joined the company and later became president in 1971. He relocated the company to Grovetown, GA. GIW's foundry produces a broad line of mining and giant dredge pumps, which are used to pump liquids with solids in suspension (i.e. mud), also referred to as slurry or pseudo-fluid.





FIGURES 1 AND 2.
Front, back, and side views of Georgia Iron Works Slide Rule

In 1960, Danforth W. Hagler, Tom Jr.'s brother, conceived and designed the GIW Hydraulic Slide Rule. The idea for this slide rule was precipitated by years of tedious calculations, where each engineer in GIW's engineering department had a thick notebook of over 100 pages of graphs for reference.

FIGURE 3.
Danforth W. Hagler, circa 1971.

Along with a package of other documents sent to me, Dan wrote me a personal letter that was his biography.

> "... I went to work for my daddy's manufacturing company in 1960. My brother Tom had already been there a couple of years and was Chief Engineer. On my first day of work I was handed a four inch thick book with many logarithmic scales to solve pumping problems. After a few days of trying to understand this, I thought there must be an easier way to solve these problems. I thought it would be great if it could be done on a slide rule, but I didn't have a clue about how to do it. One big advantage of working for my daddy in a family business was that he let me do what I wanted to do. I got a lot of strange looks over the next several months; everyone was watching the new kid (owner's son) playing with paper, scissors and scotch tape and looking up log tables.
>
> "I started cutting out log paper, scotch taping it to little boards so it would slide like a slide rule. I would mark an arrow on one of the scales and started lining up values and plotted the answers. Of course it plotted another logarithmic scale. Then I would go to the next formula. The different formulas would have common variables like pipe ID, RPM, Tons/hr, etc. Being that I used all scales the same length, I would have to adjust one of the scales to work with a different pipe ID, for example.

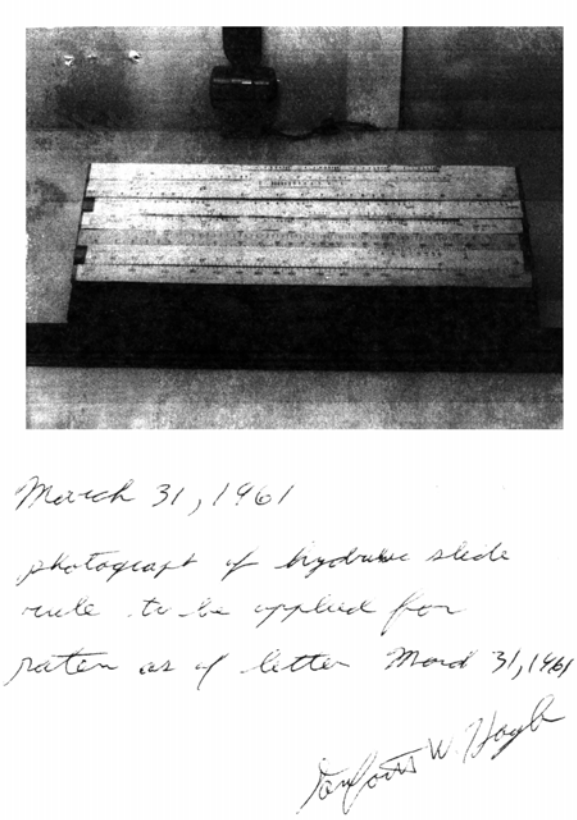


FIGURE 4.
Dan Hagler's first prototype layout of hydraulic slide rule with multiple slides.

> "I ended up with a monster of two sliding scales with three fixed scales. I approached Pickett with this monster; they were not impressed. Then it dawned on me that maybe the length of the scales should be in proportion to the power of the formula. It was a guess a tidbit of information that you don't learn in school. It all fell into place and fit on a normal slide rule. I then had to calculate the location of every mark on the slide rules and locate it for Pickett to 4 decimal places in millimeters."

Dan had given me copies of his scratch notes when he was developing the scales; one one of these pages is Figure 5 below.

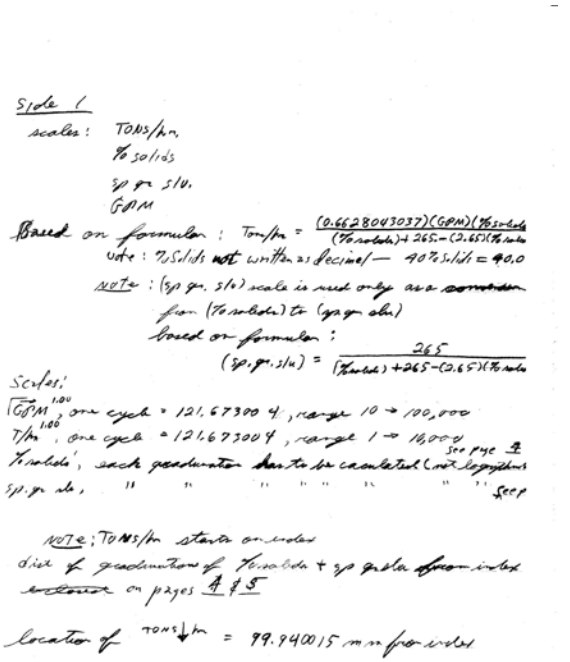
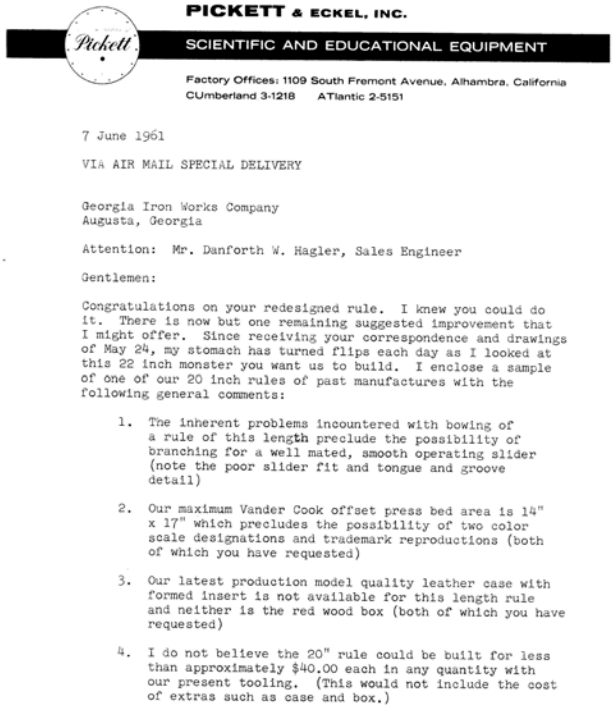

Side 1
scales: TONS/hr.
% solids
sp gr slu.
GPM
Based on formulas: Tons/hr = $\frac{(0.6628043037)(GPM)(\%\text{solids})}{(\%\text{solids})+265-(2.65)(\%\text{solids})}$
note: % Solids not written as decimal — 40% Solids = 40.0
NOTE: (sp gr. slu) scale is used only as a conversion from (% solids) to (sp gr slu)
based on formula: (sp.gr.slu) = $\frac{265}{(\%\text{solids})+265-(2.65)(\%\text{solids})}$
Scales:
GPM 1.00, one cycle = 121.67300 ¢, range 10 → 100,000
T/hr 1.00, one cycle = 121.67300 ¢, range 1 → 10,000
% solids, each graduation has to be calculated (not logarithmic) See page 2
sp gr slu, " " " " " " " " Scoop
NOTE; TONS/hr starts on index
dist & graduations of % solids + sp gravs shown on index
continued on pages 4 & 5
location of TONS/hr = 99.940015 mm from index

FIGURE 5.
Dan Hagler's scale calculations prior to submitting to Pickett.

Dan designed the slide rule with a special set of scales, based on formulas unique to the industry, which eased the burden of calculations and greatly reduced the time necessary to solve most practical dredge and mining pump and slurry pipeline problems. He worked out a copious amount of calculations for scales that were communicated in letters to M.L. Patrick, who was a Pickett & Eckel vice president at the time. One side of the slide rule contained engineering formulas involved with performance of a pump, while the other side contained everything necessary for pipeline and production calculations. At first, Dan wanted a slide rule with 20-inch scales, so there would be more divisions and relative accuracy, but the difficulties and costs of producing such a device became prohibitive. Several letters between Dan and the Pickett factory discuss the options.

A letter of June 7, 1961 reveals a lot about Pickett & Eckel's production processes at the time, and rather than paraphrase the text, I provide the two page letter from M.L. Patrick in Figures 5 and 6.


PICKETT & ECKEL, INC.
SCIENTIFIC AND EDUCATIONAL EQUIPMENT
Factory Offices: 1109 South Fremont Avenue, Alhambra, California
CUmberland 3-1218 ATlantic 2-5151

7 June 1961

VIA AIR MAIL SPECIAL DELIVERY

Georgia Iron Works Company
Augusta, Georgia

Attention: Mr. Danforth W. Hagler, Sales Engineer

Gentlemen:

Congratulations on your redesigned rule. I knew you could do it. There is now but one remaining suggested improvement that I might offer. Since receiving your correspondence and drawings of May 24, my stomach has turned flips each day as I looked at this 22 inch monster you want us to build. I enclose a sample of one of our 20 inch rules of past manufactures with the following general comments:

1. The inherent problems incountered with bowing of a rule of this length preclude the possibility of branching for a well mated, smooth operating slider (note the poor slider fit and tongue and groove detail)

2. Our maximum Vander Cook offset press bed area is 14" x 17" which precludes the possibility of two color scale designations and trademark reproductions (both of which you have requested)

3. Our latest production model quality leather case with formed insert is not available for this length rule and neither is the red wood box (both of which you have requested)

4. I do not believe the 20" rule could be built for less than approximately $40.00 each in any quantity with our present tooling. (This would not include the cost of extras such as case and box.)

FIGURE 6
Pickett quote to Dan Hagler for Hydraulic Slide Rule, page 1.


PICKETT & ECKEL, INC.
SCIENTIFIC AND EDUCATIONAL EQUIPMENT
Factory Offices: 1109 South Fremont Avenue, Alhambra, California
CUmberland 3-1218 ATlantic 2-5151

Page 2/ 7 June 1961/ Mr. Danforth W. Hagler

On the other hand, all of the above problems are eliminated if the rule is reduced to a standard 10" overall modulus. On a minimum of 10 units we could fabricate such rules to meet your specifications for $25.50 each, boxed with leather case and gold finish hardware. The master preparation, or total tooling for this unit, will run about $800.00. If you ever wanted to order this 10" rule in quantity, our standard quantity discount structure would apply.

The one question which you will have that I anticipate is whether or not you will have adequate reading accuracy on a 10" rule. We have found that with .004 graduation width, proximity of .015 between graduations is tolerable. In our opinion your graduations will not be required to reach this density.

I would appreciate your comments on the above suggestions. Quite naturally, if you still prefer the 20" rule we will fabricate same, but with reluctance.

Very truly yours,

PICKETT & ECKEL, INC.

M. L. Patrick
Vice President

MLP:sld

Enclosure: Special rule price sheet, 1 #524 ES rule

FIGURE 7.
Pickett quote to Dan Hagler for Hydraulic Slide Rule, page 2.

I cannot determine if the #524 refers to the final GIW Hydraulic slide rule, as other references now call it the N15-T. This was possibly a prototype identification number, for a contract or sales order had not yet been placed. The Special Purpose Slide Rules price sheet sent to Dan Hagler has some interesting text of historical value. Without repeating the price sheet verbatim, the item I found most fascinating was: "Special rules usually contain new scales developed by the customer. The customer should provide the calculations for these scales, using metric measurements and basing measurements on the 250 mm modulus which is standard on all 10 inch rules. Graduation distances from the left hand index should be expressed in millimeters and 4 decimals of a millimeter..."

There was a development fee of $200 charged plus $50 per scale, but if there are more than 6 scales than the charge was just $50 per scale. The unit price of these special rules was based on the physical size of the slide rule and included a leather carrying case for each rule. A minimum order of 50 units was required.

Prices were as follows:

2" x 12" (size of Model N4-ES)	$25.50
1-1/2" x 12" (size of Model N803-ES)	$21.50
1-1/4" x 12" (size of Model N1010-ES)	$12.00
6" Pocket Rules (Size of N600-ES)	$10.00

Once the order quantity reached 100 units, the price was discounted 25% and by the time the order grew to 1000 units, the discount was greater than 35%.

In Dan's package I was also given a sepia copy of the original artwork proof. He wrote, "I wanted to add the C and D scales but there was not enough room. We needed the C and D scales for multiplying and dividing, so everyone had a second slide rule." Dan said he didn't did not remember using other scales on his K&E in college, but he does remember writing on his tests "with slide rule accuracy", a standard notation. K&E was the most popular manufacturer but he liked Pickett better.

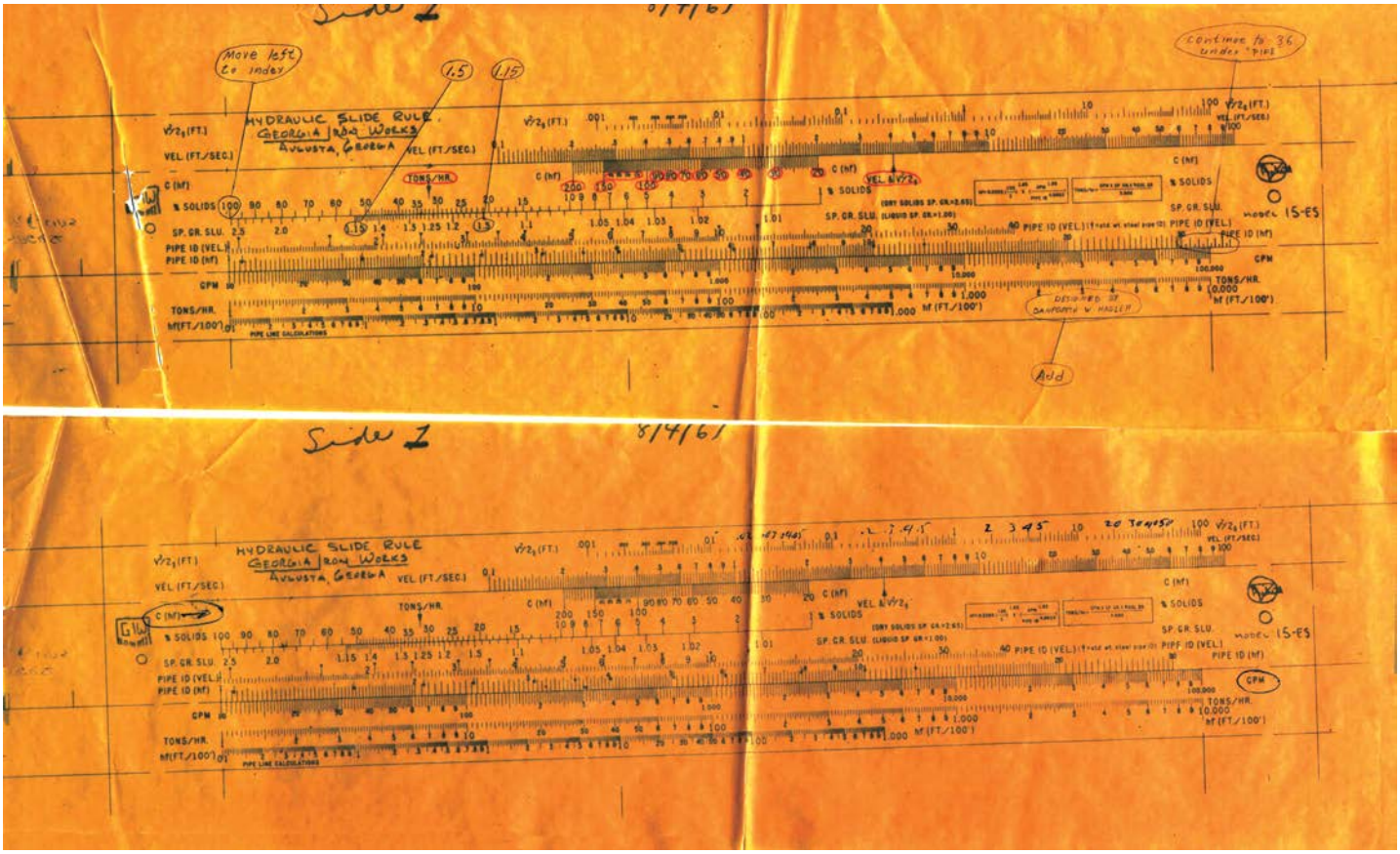


FIGURE 8.
Sepia print of artwork for the Pickett N15-T

Dan's letter to me continues:

"We gave the slide rule to our engineers and our customers' engineers. We worked closely with our customers in pumping slurry and pump selection - it was just a tool we shared - I don't think we ever sold one. I assumed we never thought there was a market."

"Once we had the slide rules in hand, my daddy told me that a few years earlier he had hired some professional engineers to design a slide rule to solve the hydraulic problems. They concluded that it was not possible. Gosh, I'm glad I didn't know that; I might not have tried it."

Dan's brother Tom wrote the users manual, which included how to use the slide rule and the theory behind the hydraulic problems. Dan still feels that this slide rule would be useful today to help one visualize the scope of the problem by seeing the effect of changing from one pipe size or

FIGURE 9.
Dan Hagler operates the IBM 1130 (1962) with a demonstration model of the Georgia Iron Works Hydraulic Slide Rule as a backdrop.

RPM to another.

Dan became interested in data processing and so moved away from sales engineering and started writing production control software on an IBM 1130 FORTRAN computer in 1962. In Figure 9 you can see Dan working on the computer with a demonstration version of the GIW Hydraulic Slide Rule hanging on the wall. I was given this training slide rule along with other specimens by the current factory representative, Mr. Reab Berry of GIW Industries, and was offered Dan's personal #1 issue version of the slide rule in a wooden box.

I found a better home for Dan's slide rule with the Smithsonian Institution's Math History Museum, a slightly larger and more diverse showcase than my own International Slide Rule Museum (ISRM). I had been in contact with Dr. Peggy Kidwell, their curator, supplying them with slide rules from George W. Richardson, Guedon, and the Roos Company, and had mentioned that I had been in contact with a person who designed a slide rule made by Pickett. One thing led to another and I was able to help Dan get all of his papers, notes, and his personal GIW slide rule added to the massive archives of the Smithsonian. They are always interested in true Americana and Dan was very excited to have his work memorialized in this fashion.

I was able to make a scan of all the materials for the International Slide Rule Museum archives at www.sliderulemuseum.com before I shipped them to the Smithsonian. For my efforts, ISRM was rewarded with a gift of the demonstration slide rule shown in the picture. I displayed this at the 2009 Oughtred Society meeting in Las Vegas and it has appeared in one of my public exhibits.

Dan Hagler is currently in his mid-seventies and sold his interest in Georgia Iron Works in 1986. In 1989, he started a software company, FBOS Systems, that was later purchased by QAD, Inc in 2006. As of this writing, he still does programming for them along with his son, Bo, and his daughter, Kate, who work in the same division.

Bibliography

1. Patrick, M. L. of Pickett & Eckel, Quotation Letter to Danforth W. Hagler of Georgia Iron Works, June 7, 1961.
2. Picket & Eckel, Special Purpose Slide Rules price list and quantity discount schedule, circa 1961.
3. Danforth W. (Dan) Hagler letter and personal slide rule development notes and records sent to Mike Konshak, Curator, International Slide Rule Museum, October 25, 2008.
4. T. W. Hagler Jr., D. W. Hagler, *Hydraulic Slide Rule Instructions, Formulas and Charts*, Engineering Department, Georgia Iron Works, (c)1961. Download at http://www.sliderulemuseum.com/Manuals/Pickett_N15T_GIW_Hydraulic_SR_Manual.pdf
5. T. W. Hagler, *Hydraulic Slide Rule Instructions, Formulas and Charts*, Georgia Iron Works, circa 1969. Download at http://www.sliderulemuseum.com/Manuals/GIW_Hydraulic_SR_Instructions.pdf

Mike Konshak is a mechanical engineer specializing in electronic products design. He has collected slide rules since 2003, and as curator for his sliderulemuseum.com has become a world-wide recognized source for information on slide rules and related education aids.

In Honor of William Oughtred, 1575-1660

We pause for a moment to honor William Oughtred, who died 350 years ago, June 30, 1660. In 1622, Oughtred used the logarithmically divided scale developed by Edmund Gunter to devise the first slide rule. He also invented a circular slide rule in 1630.

William Oughtred was educated at Eton School and at King's College, Cambridge. He was ordained an Episcopal minister in 1603. In 1610 he became rector of Albury Church, Surrey, England, where he served for 50 years until his death.

He worked and experimented with mathematics and published several books during this time, including his most important work, *Clavis Mathematicae* (The Key to Mathematics) in 1631, and *Circles of Proportion and the Horizontal Instrument* in 1632, in which he described slide rules.

For additional information see *William Oughtred – a Great Sevententh-Century Teacher of Mathematics* by Florian Cajori, 1916. Reprints are available on the internet at a cost of less than $15.