TABLE I

	Starting Values			After 106 days			
	Iodine Value	Refractive Index	Color	Flavor off after days	Decrease in Iodine Value	Increase in Refractive Index	Final Color
All-hydrogenated Shortening A.	69.6	1.45300	20/2.0	20	32.5	.00500	15/1.1
All-hydrogenated Shortening B.	68.8	1.45285	15/1.7	20	26.8	.00380	10/0.7
All-hydrogenated Shortening C.	64.8	1.45245	20/2.2	14	33.6	.00640	35/3.75
All-hydrogenated Shortening D.	67.5	1.45270	20/1.9	14	35.1	.00625	35/4.7
Compounded Veg. Shortening E.	78.7	1.45380	35/3.8	14	36.2	.00700	35/6.1
Compounded Veg. Shortening F.	95.3	1.45610	20/2.5	10	35.3	.00615	20/1.2
Cottonseed Oil (salad oil) G...	112.7	1.45810	35/6.6	10	46.0	.00860	35/5.3
Corn Oil (salad oil) H.........	129.1	1.46070	35/4.5	4	46.0	.00880	35/6.1

Changes in Oils and Fats Due to Atmospheric Oxidation

By HERMAN ASPEGREN

In order to find out what changes occur in various kinds of shortening and different kinds of oil if same are exposed to constant heat and atmospheric oxidation, a test was made this spring in the laboratories of the Portsmouth Cotton Oil Refining Corporation. 300 grams of shortening or oil were placed in a 600cc. beaker, covered with a cover glass, and left in a Dekhotinsky oven exposed to 145° F. for 106 days.

Tests were made at certain intervals, determining the Refractive Index, Iodine Value and color, also observing when a rancid odor appeared, and the results are shown in the various charts.

The different samples were marked A, B, C, D, E, F, G and H. The samples represented known brands of different manufacture. Samples A, B, C and D were all hydrogenated shortening. Samples E and F represented vegetable compounded shortenings. Sample G was a cotton oil winterized (salad oil), and sample H was a corn oil (salad oil).

During the exposure the Refractive Index increased considerably and the Iodine number decreased. The color also underwent considerable changes. In some of the samples the color rose sharply during exposure for a few days and then the color irregularly decreased during the first 20 days, after which time the color again increased, and in some cases very considerably.

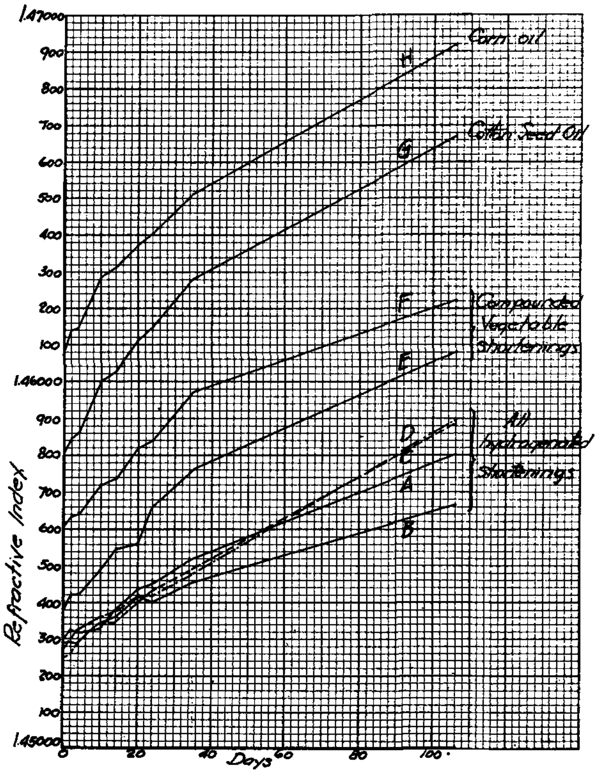


Fig. II

In Table I are tabulated the original as well as the final Iodine numbers, Refractive Indeces and colors, also days of exposure when rancid

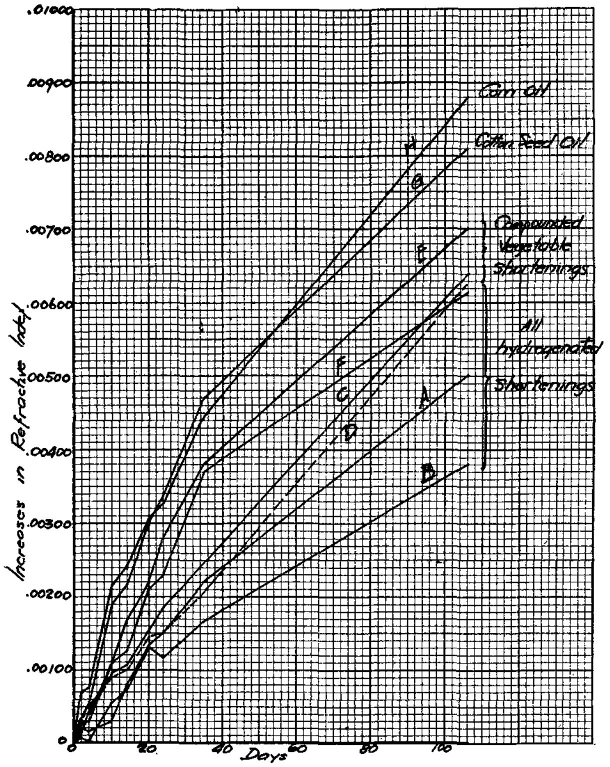


Fig. III

odor distinctly appeared.

In Table II are shown the curves of the gradual change in Refractive Index, and in Table III are plotted the curves showing the gradual increase in Refractive Index.

In Table IV are plotted the curves showing the gradual decrease in Iodine numbers.

On studying the curves shown in Tables II, III and IV, it will be noticed the all-hydrogenated shortenings as a class had the least increase in Refractive Index, as well as the least decrease in Iodine value. The compounded shortenings had more increase in Refractive Index and also slightly more decrease in Iodine number, and on the curves the vegetable shortenings come next to the all hydrogenated shortenings. The salad oils of cottonseed oil and corn oil showed nearly the same increase in Refractive Index and on the curves come considerably above the compounded shortenings, however, the increase in Iodine number for the Cottonseed salad oil did not materially differ from the vegetable compounded shortening; but the Cornoil Salad oil's decrease in Iodine value was considerably more than for cottonseed oil and the greatest decrease noticed.

It may further be noticed that with one exception, sample D, the increase in Refractive Index was most rapid during the first 35 days, and most noticeable for the compounded shortenings and salad oils.

From curves on Table V it may be noticed that there is no evidence of an induction period. The comparatively small change between the second and fourth day in some of the samples is interesting.

As no determinations were made between the 35th and 106th days, the curves could not be drawn correctly between these days, but in most cases it probably is not a straight line as drawn, but rather curved, especially so for the salad oils and the compounded shortenings.

It should be mentioned that no analyses were made to determine of what oils the various shortenings were made. No doubt, however, cottonseed oil was the predominating oil; however, other oils may have entered to more or less extent.

It will be noticed that three periods of color changes occurred. The first period showed a great increase in color for C and D, all-hydrogenated shortenings, and the compounds E and F. However, the all-hydrogenated

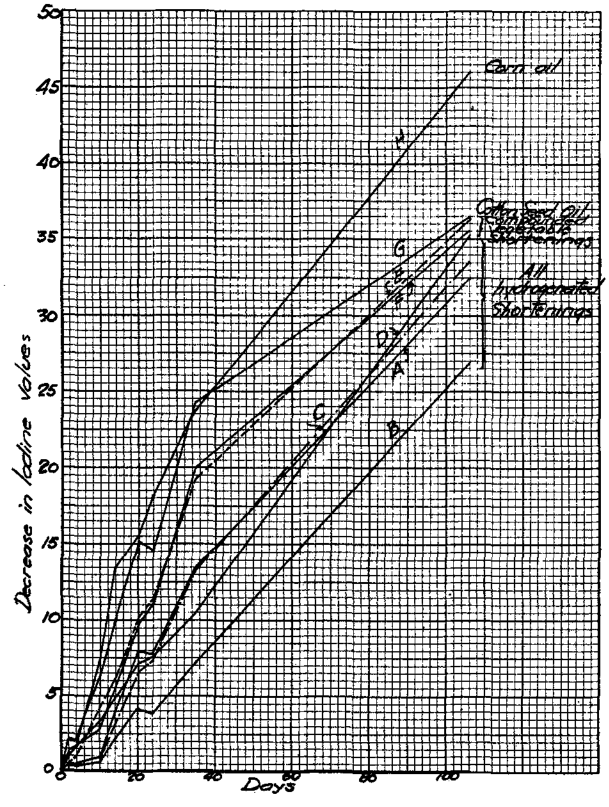


Fig. IV

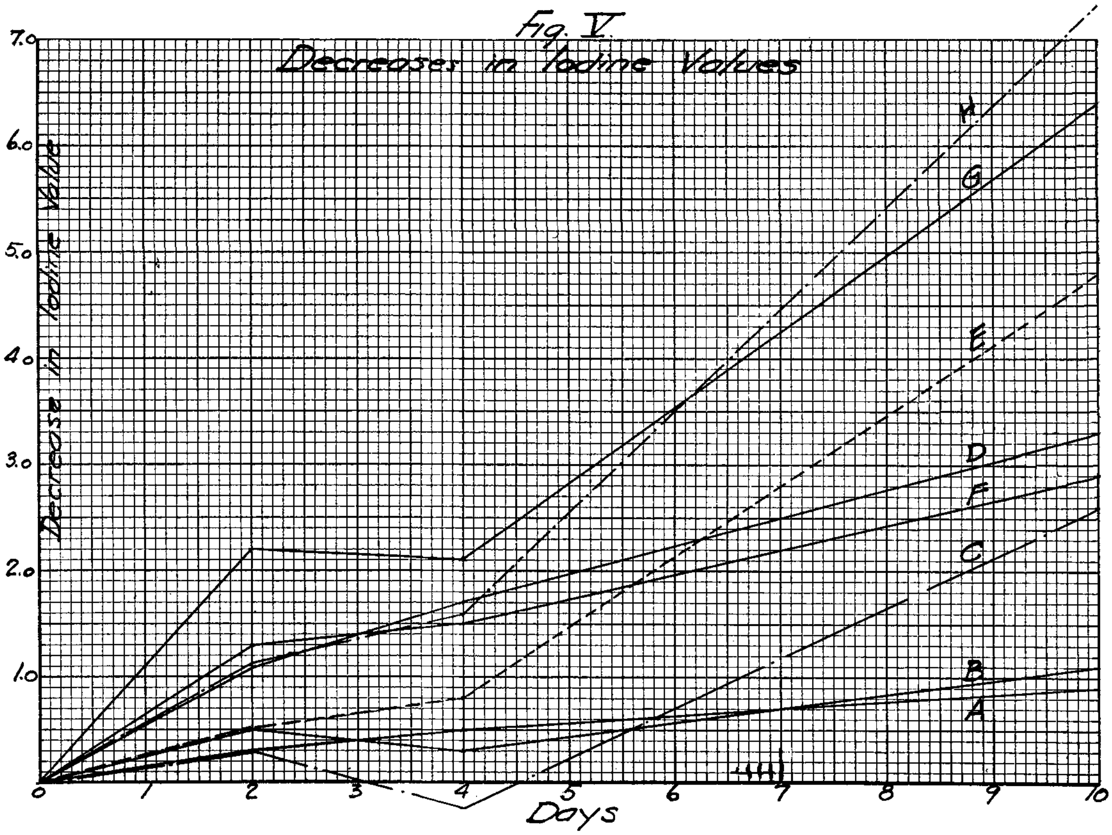


Fig. V
Decreases in Iodine Values

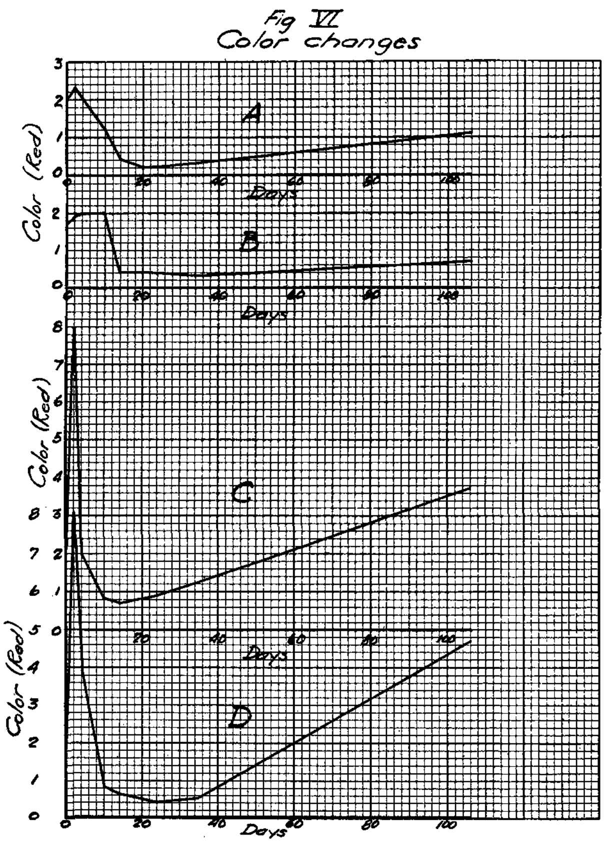


Fig VI
Color changes

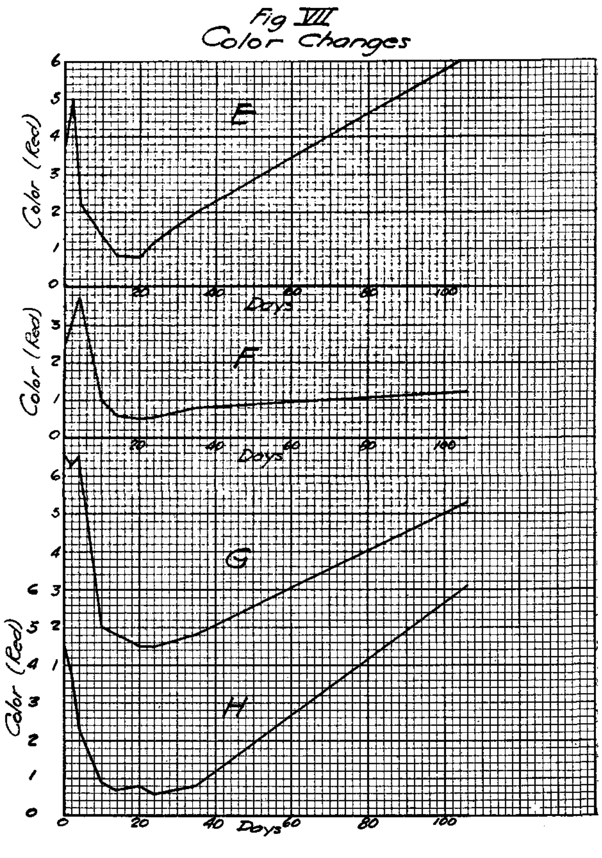


Fig VII
Color Changes

TABLE VIII

Sample	Original Color	High	Low	Final Color	Maximum Increase from Orig. Color	Maximum Decrease from Orig. Color
A	2.0	2.3	.2	1.1	.3	1.8
B	1.7	2.0	.3	1.7	.3	1.4
C	2.2	8.0	.7	3.8	5.8	1.5
D	1.9	8.1	.4	4.7	6.2	1.5
E	3.8	6.1	.9	6.1	2.3	2.9
F	2.5	3.7	.5	1.2	1.2	2.0
G	6.6	6.6	1.5	5.3	.0	5.1
H	4.5	6.1	.7	6.1	1.6	3.8

shortenings A and B (same brands), and the oils G and H, did not increase in color. The lightest color appeared around the 20th day of exposure, after which time in all cases an increase in color occurred, this increase being very substantial for samples C and D (all-hydrogenated). Sample F, compound, showed hardly any increase; again the other compound sample, E, showed very great increase. Both the salad oil samples, G and H, increased in color substantially.

In Table VIII is given a tabulation of the original color before the heat treatment and the highest and lowest color as well as the final color. Any color incl. 2.5 red is read with 20 yellow; over 2.5 red with 35 yellow, and 10 red or under with 10 yellow.

Some experiments have also been made to determine the changes in Iodine number and color when an oil or shortening was exposed to about 360-375° F. for 5 hours under exclusion of air, and the results of those tests are shown in Table X. Those results are mentioned because they may throw some light on the changes mentioned. The changes which took place in the oven no doubt were due to oxidation as well as polymerization, but on the other hand the changes which took place during the heat exposure to 360-375° F. under exclusion of air probably were principally due to the polymerization.

It will be noticed that when the oils and shortenings were exposed to 360-375° F. under exclusion of air, the Iodine number on all-hydrogenated shortening decreased with 2.9, compounded shortening on an average with 2.1 and all-hydrogenated shortening (titer of 52 to 56) decreased with an average of 1.7, and cottonseed oil (salad oil), decreased with an average of 2.6.

At this time I would like to mention that the oils used in the test with results as shown in Table IX were cottonseed oil. The tests having

(*Continued on next page*)

TABLE IX

Date 2/26/7 Kind of Sample	Iodine Values Before	Iodine Values After	Titer Before	Titer After	Color Before	Color After
Hardened Oil	33.7	32.0	52.0	53.4	2.0	2.8
Hardened Oil	29.9	28.3	54.8	55.0	1.7	2.7
Hardened Oil	15.7	15.3	57.4	57.4	3.7	6.3
Hardened Oil	21.3	18.0	56.0	56.3	3.8	6.6
All-hydrogenated Shortening	68.0	65.1	36.1	35.9	1.8	2.9
Average of 6 samples— Compounded Vegetable Shortening	93.6	91.4	37.7	38.8	2.6	2.6
Average of 4 samples— Compounded Vegetable Shortening	91.4	89.3	37.8	38.0	2.9	2.8
Average of 2 samples— Cottonseed Oil	109.3	105.3	35.3	36.2	...	...
Average of 2 samples— Cottonseed Oil	108.4	107.1	....	....	6.0	2.4

been made three years ago, naturally other oils and shortenings were used at that time than were used in the oven tests.

It may also be interesting to note that a small but consistent increase in the titer took place when the oils and shortening were heated to 360-375° F.

The result of the tests made by heating oils and shortening to 360-375° F. under exclusion of air coincides closely with actual experiences during the deodorization process, it being a frequent occurrence that a salad oil during the deodorization process decreases with 2 in Iodine number.

It seems that the changes in Iodine number and the Refractive Index are due both to oxidation and to polymerization. To what extent each factor influences the changes has not been attempted to determine.

No attempts were made in the tests mentioned to find out whether the increase which takes place in the color of some of the all-hydrogenated shortening and the compounded shortenings, as shown by the tests in the heating oven, is due to the catalyzer used in the hydrogenation process, or to other causes.

I wish to express my appreciation to Mr. Herbert Wall and Mr. Arne Gudheim for their cooperation and assistance in carrying out the oven test, and to Mr. A. W. Putland for assistance in making the tests made under exclusion of air.

Refining Test Committee Report

C. B. CLUFF, Chairman.

VERY little work has been undertaken by the Refining Committee during the past year. It was proposed to give further study to the refining of soya bean oil and coconut oil in the endeavor to improve the conditions specified for temperature and time of agitation. Only a few tests were made, however, on soya bean oil and none on coconut oil. Hence this work should be continued next year.

Change in Tentative Method for Refining Soya Bean Oil

The requirement of one-half and two-thirds of the maximum amount of lye permitted for hydraulic crude cottonseed oil has been rendered a little uncertain by limiting the maximum lye for cotton oils with low F. F. A. to 80 per cent of the permitted maximum. Hence, to avoid ambiguity in expressing the lye to be used for soya bean oil, we recommend the use of a formula as stated below which makes no change in the lye now required, but puts it in more definite form. This section will then read as follows:

"RULE 274. Miscellaneous oils.

Section 3. Soya Bean oil (Tentative Method)

The apparatus and general procedure shall be the same as prescribed for hydraulic pressed Crude Cottonseed Oil, with the following exceptions: Maximum caustic soda to be used in refining shall be calculated from the following formula: $\frac{\text{F. F. A.}}{7.8} + .36 = \text{Max. NaOH.}$ Two refining tests shall be made, using 14 degree lye in both cases, one test to be made with the maximum caustic soda calculated from the formula and the second with three-quarters of this amount."

Change in Tentative Method for Refining Corn Oil

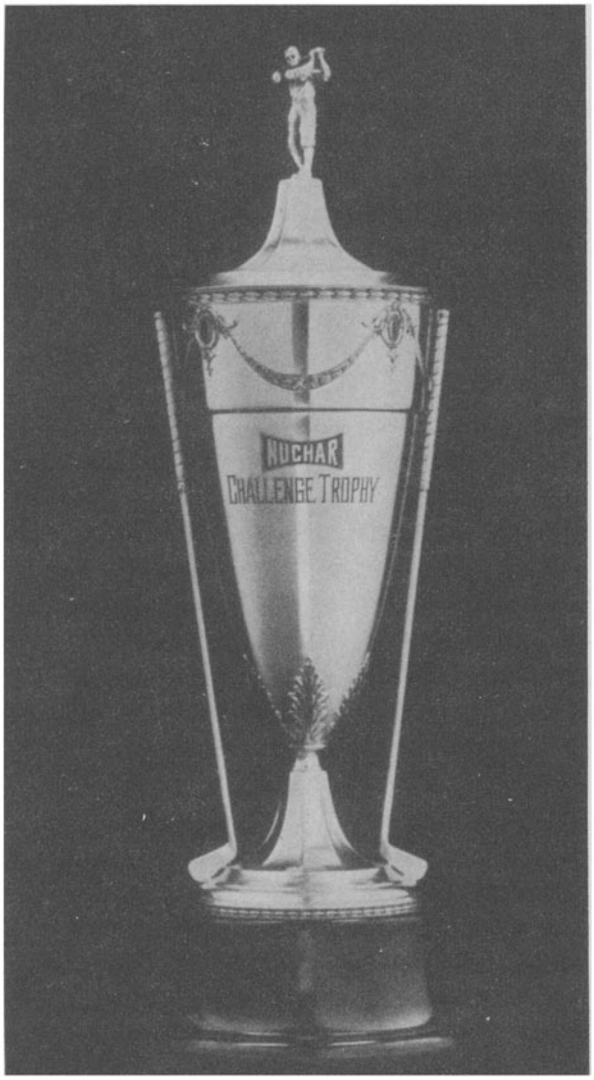
For the same reason as mentioned under the heading "Soya Bean Oil" we recommend the use of a formula for calculating lye to be used in refining corn oil, as stated below. This section will then read as follows:

"Section 4. Corn Oil (Tentative Method)

The apparatus and general procedure shall be exactly as prescribed for hydraulic pressed crude cottonseed oil, with the following exceptions: Maximum caustic soda to be used in refining shall be calculated from the following formula: $\frac{\text{F. F. A.}}{7.8} + .36 = \text{Max. NaOH.}$ Two refining tests shall be made, using 16 degree lye in both cases, one test to be made with the maximum caustic soda calculated from the formula and the second with three-quarters of this amount."

We recommend the adoption of these two changes.

C. B. Cluff,
Chairman, Refining Test Committee.



The Nuchar Cup

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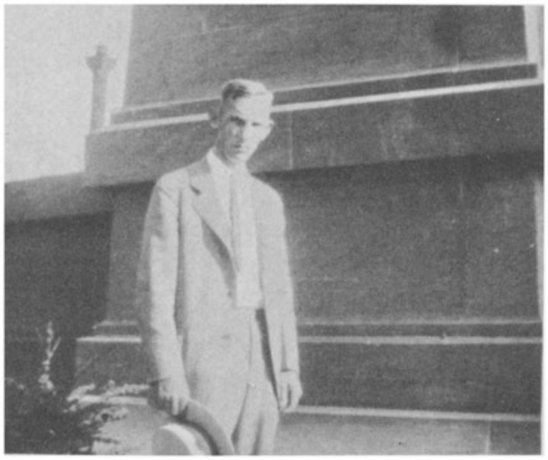

L. B. Forbes

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CHALLENGE:

The holder of the Nuchar Cup, both pictured in all the shining glory with which our engraver was capable, has issued a challenge to all and sundry among the chemists attending at New Orleans, May 12-13. Mr. Forbes throws down the gauntlet in the following brief plain words:

"I am serving notice on all would be golfers who are chemists that I am prepared to defend actively my laurels won in New Orleans last year, and that I am wondering whether it is worth while even to carry the cup to New Orleans next month as I will save the trouble by leaving it at home, as it will be only a matter of 18 holes and I will have to then bring it back.

For the information of those who were not at Hot Springs last week I beg to advise that I won the second low gross at the Valley Division Tournament with a rotten 79. Even with such a score as that I should be capable of handling any and all chemists who think they can play the ancient and glorious game.

Yours truly,

(Signed) L. B. FORBES."