to the data shown in the previous paper[1] it will be seen that the relative amounts of non-basic nitrogen in humus are somewhat less than the amounts obtained by hydrolyzing the soil as a whole.

Considering the different groups of nitrogen compounds obtained from humus, the preceding data show that in absolute amounts less amide, basic and non-basic nitrogen were contained in the humus than were split off upon hydrolysis of the soil as a whole. But on the other hand the humus nitrogen bodies, as such, contained relatively more amide and basic nitrogen and less non-basic nitrogen than the soil nitrogen as a whole. In other words, the nitrogen of soils soluble in 3% sodium hydrate is combined in bodies differing somewhat from the nitrogen bodies not soluble in the solvent.

While it cannot be definitely stated that no hydrolysis took place as a result of the treatments employed in the extraction of the humus and in the solutions subsequently, it seems probable that a considerable part of the humus nitrogen had already undergone some hydrolytic change in the soil. As previously stated, it is certain that the protein complex must become split up into simpler components before its nitrogen becomes available to plants. These components are now known to consist principally of acid amides and amino acids. The humification process, resulting in a considerable simplification of the protein complex with the probable cleavage of the amide, diamino and monoamino acids, therefore, is to be looked upon as a step towards the production of available nitrogen.

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A PRELIMINARY STUDY OF THE CHANGES OCCURRING IN MEATS DURING THE PROCESS OF DRYING BY HEAT AND IN VACUO.[2]

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It is a well known fact that some food products, when heated to 100–105°, give a lower percentage of dry substance, than when dried *in vacuo* at room temperature (20°), or lower.[1] Especially is this difference apparent for substances which contain certain sugars, oils, or fatty acids. On the other hand, there is a tendency for some of the fats to oxidize, when heated to 100–105°, and thus indirectly the dry substance of such materials is increased.

Of the two methods of drying, the use of heat at 100–105°, with or with-

[1] *Loc. cit.*

[2] The results presented in this paper formed part of the thesis which was submitted by Lloyd H. Davis to the Graduate School of the University of Illinois in partial fulfillment of the requirements for the degree of Master of Arts in Chemistry.

out a current of gas passing over the products, is generally used. It is simpler and can be carried out in a comparatively short time. In commercial work, the vacuum method is not practical, except in special cases where the heat method gives very erroneous results.

In addition to the total loss or gain upon drying food materials at high temperatures, it is also of interest to study the chemical changes that take place during the process of drying *in vacuo* and some desiccating agent, as sulfuric acid, at room temperature. That is, to compare the composition of the fresh undried sample with the composition of a representative portion dried *in vacuo*.

The specific object of this investigation was, therefore, to procure information as to the comparative value of these two methods of drying with reference to meats. It involved: (1) a comparison of the dry substance and fat content of samples dried by the heat and vacuum methods; (2) a study of the influence of the resulting differences in the dry substance and the fat, upon the percentage values of the forms of nitrogen, and (3) a determination of the effect of vacuum drying upon the forms of nitrogen in the fresh undried meats.

Experimental.

Preparation of the Samples.—The meats were thoroughly ground and mixed. A portion of the fresh samples was analyzed immediately. The remainder of each sample of meat was desiccated as follows: It was spread out in thin layers over the bottom of Petri dishes. These vessels were then placed in a tight receptacle, which was in turn surrounded by a mixture of salt and ice. As soon as the meat was frozen, the dishes were transferred quickly to chilled vacuum desiccators which were then evacuated and put in a refrigerator. When the meat became dry enough to curl up around the edges, the dishes were carefully removed in order to turn the meat over and break it up. The sulfuric acid was also renewed at this time. The desiccators were again evacuated. The drying was then continued at room temperature (20°). After drying five or six days, the meat was taken out, and ground to pass through a millimeter sieve. The entire sample was again spread out in dishes and dried *in vacuo* at room temperature for two to three days. It was then mixed for analysis.

Determinations Made and the Methods Used.—The following constituents were determined in the fresh and desiccated meats: dry substance, fat, total nitrogen, water-soluble nitrogen, coagulable nitrogen, proteose nitrogen and creatin.

The methods used were as follows: 1. Dry substance by (*a*) the heat method and (*b*) the vacuum method.

(*a*) The weighed samples were dried at 100–105° in an air oven for 12 hours. They were then heated for periods of one and a half to two hours, until they became constant in weight.

(*b*) The samples were put in vacuum desiccators containing *pure* concentrated sulfuric acid. The desiccators were evacuated and placed upon an automatic shaker. The drying was continued for 4 to 5 days, the acid being renewed once during this time. The samples were then dried for 24-hour periods until they became constant in weight.

The dishes used in the drying were in all cases lead caps provided with closely fitted covers. The measurements of the dishes were $2^1/_4$ inches in diameter and $^3/_4$ inches deep. The caps and the corresponding covers were kept together and as soon as they were removed from the oven, in the case of the heat method, the covers were put over the caps at once and the whole placed in a desiccator. No more than six caps were put in the same desiccator. The weighings were made in about 45 minutes, after removing the dishes from the oven. In the case of the vaccum method, when the air was allowed to enter the desiccator in order to remove the dishes, it was dried by passing through sulfuric acid.

2. Fat. The dried residues, from 1*a* and 1*b* above, were extracted for at least 24 hours with dry redistilled ether. The fats were heated at 100–105° until they became constant in weight.

3. Total nitrogen. The Kjeldahl-Gunning-Arnold method was followed.[2] This involved the uses of mercury, potassium sulfate, and sulfuric acid. The digestion was continued for $2^1/_2$ hours after the charred mixture became clear.

4. Water-soluble nitrogen. In the case of the desiccated meats, the method of making the cold water extract was the same as the one which was formerly used in this laboratory.[3] For the fresh meats, a modification of this method was followed. This involved the use of a centrifuge and thoroughly extracted sand. The temperature of the water was about 10° in both cases.

5. The soluble nitrogen was determined by the same method as given in 3 above.

6. In the case of the coagulable nitrogen, aliquot portions of the water extract were evaporated to 30 cc., neutralized to litmus, heated again and filtered. The nitrogen was determined in the coagulum.

7. For the proteose nitrogen the filtrates from 6 were evaporated to 30 cc. After acidifying them with sulfuric acid, they were saturated with zinc sulfate. The nitrogen was then determined in the separated protein.

8. The creatin was estimated in portions of the water extract from which the coagula had been removed. Folin's method[4] as modified by Benedict and Myers, and by Emmett and Grindley was used.

Discussion of Results.

Effect of the Methods of Drying upon the Percentage of Dry Substance, Fat and Nitrogen.

The data for the dry substance and fat are given in Table I, calculated

to the fresh basis. It will be seen, comparing the values for the heat and the vacuum methods, that there is a distinct difference between the percentage of dry substance in the two series of data. The vacuum method gives higher results in every case. This fact is more pronounced with the desiccated meats.

TABLE I.—THE PERCENTAGE OF DRY SUBSTANCE AND FAT IN THE FRESH AND DESICCATED MEATS.

	Dry substance.				Fat.			
	Fresh meats.		Desiccated meats.		Fresh meats.		Desiccated meats.	
Lab. No.	Vacuum method.	Heat method.	Vacuum method.	Heat method.	Vacuum method.	Heat method.	Vacuum method.	Heat method.
312112	29.37	29.00	98.48	98.19	4.89	5.35	17.78	17.23
312512	26.83	26.69	99.05	97.18	3.79	3.90	15.64	15.62
313812	25.62	24.85	98.17	95.24	2.17	2.04	6.75	6.55
313912	25.89	24.97	98.51	97.25	1.62	1.54	4.99	4.76
313312	24.58*a*	lost	96.85	94.91	1.37*a*	lost	5.56*a*	4.32*a*
312612	24.40	23.95	*b*	*b*	2.02	2.07	*b*	*b*
313412	*b*	*b*	98.65	96.60	*b*	*b*	6.90	6.42
313512	*b*	*b*	96.71	95.35	*b*	*b*	9.64	9.68
Average	26.42	25.89	98.06	96.39	3.12	2.98	10.28	10.04

a Omitted from average.
b Not determined.

The average values are, for the fresh meats, 26.42 and 25.89% by the vacuum and heat methods, respectively, and for the desiccated meats, they are 98.06 and 96.39%. In the former case, there is a difference of 0.53% in favor of the vacuum method, and in the latter case, one of 1.67%. Expressed in per cent. of the total dry substance, determined by the vacuum method, the differences are 1.6 and 2.0% for the fresh and desiccated meats, respectively.

Comparing the data for the fat, there is no evidence as to whether the samples that were dried by the vacuum method gave higher, or lower, results than those that were dried by the heat method. With the exception of the one sample of the fresh meat, No. 312112, the differences are no greater than what one might expect to find between duplicate or triplicate determinations. Thus, the difference between the average values for the two series of data is 0.14% for the fresh meats, and 0.24% for the desiccated meats, while the average difference between duplicates by the heat method is 0.20, and by the vacuum method, 0.18%. The average results for the fat are for the fresh meats 3.12 and 2.98% for the vacuum and heat methods respectively, and for the desiccated meats, 10.28 and 10.04%.

In Table II, the data for the fat are calculated to the dry basis, using the two different values for dry substance. Excepting the sample of fresh meat No 312112, the differences between the two series of data

cannot be attributed to the methods of drying, any more than to the errors that might have occurred in the sampling and the analysis. Taking the averages for the fresh meats, the values for the fat are 9.28 and 9.41% for the vacuum and heat methods, respectively, and in the desiccated meats, they are 10.44 and 10.36%.

TABLE II.—THE PERCENTAGE OF FAT IN THE FRESH AND DESICCATED MEATS. Calculated to the Dry Basis.

	Fresh meats.		Desiccated meats.	
Lab. No.	Vacuum method.	Heat method.	Vacuum method.	Heat method.
312112	16.65	18.45	18.05	17.55
312512	14.13	14.61	15.79	16.07
313812	8.47	8.21	6.88	6.88
313912	6.26	6.17	5.07	4.89
313312	5.53	lost	5.74	4.55
312612	8.28	8.65	*a*	*a*
313412	*a*	*a*	6.99	6.65
313512	*a*	*a*	9.97	10.15
Average all, A	9.28*b*	9.41*b*	10.44*b*	10.33*b*
Average, B, 312112 to 312612	10.21	...	10.31	...

a Not determined.
b Omitted 313312.

From the above discussion of the data for the dry substance and fat, it would seem that the differences that occurred in the former constituent may be due to one or more of the following: (1) mechanical occlusion of water in the desiccated meats, or (2) loss of fatty matter in the subsequent heating of the fats extracted from the desiccated meats, or (3) the possible, although less probable, partial decomposition of the fresh meats by bacteria, during the early stages of the desiccation.

In order to show the influence of the two methods of drying upon the nitrogenous bodies in the meats, the results were calculated to the dry basis, using the two respective values. The averages are, for the fresh meats, 13.00% when vacuum dried, and 13.28% when heat dried, and for the desiccated meats, 13.50% and 13.74%, respectively. These differences are slight and as already stated for the dry substance, they amount to but 1.6 and 2.0%. They are no greater than those that were found to exist between the duplicate determinations.

To obtain more information as to the effect of heat upon the total nitrogen in meats, this constituent was determined in *triplicate* on representative portions of a sample of beef. Four portions were dried as follows: (*a*) 20 hours at 100–105°; (*b*) 96 hours at 100–105°; (*c*) until constant in weight *in vacuo* at room temperature (20°); and (*d*) 48 hours at 130°. The results, calculated to the fresh basis, are:

	Per cent. N.
(*a*) Dried at 100–105° for 20 hours	3.624
(*b*) Dried at 100–105° for 96 hours	3.615
(*c*) Dried *in vacuo* 20–25° to constant weight	3.632
(*d*) Dried at 130° for 48 hours	3.450

From these data, it would seem that there was but very slight loss, if any, on drying the meats at 100–105° as compared to the value found by the vacuum method. There was an apparent loss of nitrogen, however, upon raising the temperature to 130°.

Changes Occurring in the Forms of Nitrogen in Meats during Desiccation.

It has been shown in this laboratory that the composition of meats, when air-dried, compares very favorably with that of the fresh undried samples, when the two sets of data are calculated to the dry basis.[8] In these instances the analyses included dry substance by heat, fat, ash and total nitrogen.

TABLE III.—THE PERCENTAGE OF THE FORMS OF NITROGEN IN THE FRESH AND DESICCATED MEATS.

	Total nitrogen.		Water-soluble nitrogen. Total.		Coagulable.		Proteose.		Creatin.	
Lab. No.	Fresh meats.	Desiccated meats.	Fresh meats.	Desiccated meats.	Fresh meats.	Desiccated meats.	Fresh meats.	Desiccated meats.	Fresh meats.	Desiccated meats.
312112	3.49	12.03	0.868	2.462	0.486	1.189	0.026	0.054	...	0.626
312512	3.42	12.30	0.746	2.372	0.386	0.788	0.028	0.181	...	...
313812	3.45	13.40	0.798	2.615	0.393	1.031	0.023	0.079	0.130	0.336
313912	3.51	13.99	0.717	2.535	0.374	1.209	0.014	0.061	0.115	0.503
313312	3.45	14.30	0.845	2.902	0.463	1.246	0.016	0.100	...	0.601

Referring to Tables I and III, the composition of the fresh and desiccated meats can be compared for corresponding samples, Nos. 312112 to 313312, inclusive. Owing to the higher per cent. of dry substance in the desiccated meats, their average composition differs greatly from that of the fresh samples. Therefore, a comparison of these data, calculated to the dry basis, will throw more light upon the question at issue.

In Table II, the data for the fat, calculated to the dry basis, show that the average percentage values are 10.21 and 10.31, respectively, for the fresh and desiccated meats. Comparing the results for the corresponding samples, the differences in fat are quite great in some cases. Thus, for sample No. 312112, the per cent. of fat in the fresh meat is 16.65, and in the desiccated meat 18.05. And in No. 313812, the percentage values are 8.47 and 6.88, respectively, for the undried and dried meats. There is no apparent explanation for this irregularity in the data.

The results for the nitrogen upon the dry basis are given in Table IV. The total nitrogen, with the exception of No. 312512 is higher in the desiccated meats. The average values are 13.14% for the fresh samples, and 13.45% for the desiccated samples. This difference is possibly the

result of the reduction of some of the nitrogenous bodies, due to the action of bacteria in the early stages of the desiccation.

TABLE IV.—THE PERCENTAGE OF THE FORMS OF NITROGEN IN THE FRESH AND DESICCATED MEATS.

Results Calculated to the Dry Basis.

	Total nitrogen.		Water-soluble nitrogen. Total.		Coagulable.		Proteose.		Creatin.	
Lab. No.	Fresh meats.	Desiccated meats.	Fresh meats.	Desiccated meats.	Fresh meats.	Desiccated meats.	Fresh meats.	Desiccated meats.	Fresh meats.	Desiccated meats.
312112	11.89	12.22	2.95	2.50	1.655	1.207	0.089	0.055	...	0.636*a*
312512	12.75	12.42	2.78	2.39	1.439	0.796	0.104	0.183	...	...
313812	13.45	13.65	3.11	2.66	1.534	1.050	0.090	0.101	0.507	0.342
313912	13.57	14.20	2.77	2.57	1.445	1.226	0.054	0.070	0.444	0.504
313312	14.02	14.77	3.44	3.00	1.884	1.287	0.065	0.103	...	0.621*a*
Average	13.14	13.45	3.01	2.63	1.591	1.113	0.080	0.102	0.475	0.423

a Omitted from average.

The soluble nitrogen is distinctly lower in the desiccated meats than in the undried samples, the averages being 2.63 and 3.01%, respectively, or a percentage difference of 12.8. The fact that the percentage of soluble nitrogen is lower in each of the five samples of desiccated meat, is significant. This difference in the solubility of the nitrogen is due probably to the physical nature of the desiccated meats, since they are made up of fine particles which are hard, brittle, and horny.

The fact that the fresh samples were extracted by the centrifugal method, and the desiccated meats by the "beaker" method may be responsible for some of the differences in the percentage of soluble nitrogen in the two kinds of meat. The completeness of the extraction by the beaker method has been tested with fresh meats in this laboratory.[1]

TABLE V.—ACCUARACY OF THE WATER EXTRACTION METHOD WITH DESICCATED MEATS.*a*

	Water extracts.				
Lab. No.	I.	II.	III.	Average.	Analysts.
3135121	2.520	2.571	2.578	2.556	Davis and Emmett 1912
3135122	2.591	2.546	2.578	2.572	
3135123	2.496	3.844*b*	2.554	2.525	
Average	2.536	2.559	2.570	2.551	
3246131	2.020	2.042	1.748*b*	2.031	Davisson and Emmett 1913
3246132	2.049	2.051	1.998	2.030	
Average	2.034	2.046	1.998	2.030	

a From the report of the referee (Emmett) on the separation of nitrogenous bodies in meats: U. S. Dept. Agric., Bur. Chem., *A. O. A. C.* 1912 and 1913.

b Omitted from average.

[1] The data in Table V show that this method works well with desiccated meats.

It will be seen that the data for the heat coagulable nitrogen (Table IV) are lower in the desiccated meats. The average values are 1.113% for the dried samples, and 1.591% for the fresh samples, a difference of 30%. While the method for determining this form of nitrogen is not as accurate as that for the total, the errors due to the method, when it is carried out properly, are much less than the differences found here.

It is interesting to note that these differences between the fresh and desiccated meats, in the case of the soluble and the coagulable nitrogen are nearly the same, being 0.452 and 0.478%, respectively. In other words, it appears that one of the fundamental changes that took place during the process of the desiccation of the meats was the partial coagulation of the water-soluble protein, and as a result, the solubility of the total nitrogen was decreased.

The data for the proteose nitrogen indicate, with the exception of sample No. 312112, that there was a distinct increase of this constituent in the desiccated meats. The averages for the fresh and the desiccated samples are 0.080 and 0.102%, respectively.

This change in the proteose form is due probably, in part at least, to the action of enzymes during the preliminary drying. While it is generally admitted that the acid zinc sulfate method of determining the proteose nitrogen is far from satisfactory, the fact that four of the five desiccated samples had higher values than the corresponding fresh samples, is good evidence that the difference is due to the chemical composition of the meat rather than to the errors in the method.

Regarding the creatine data, little can be said, on account of the small number of determinations that were made on the fresh meats. The average value for the fresh meats is 0.475%, and for the desiccated meats, 0.423%.

TABLE VI.—THE PERCENTAGE OF THE FORMS OF NITROGEN IN THE FRESH AND DESICCATED MEATS.

Results Calculated to the Dry and Fat-free Basis.

	Total nitrogen.		Water-soluble nitrogen.							
			Total.		Coagulable.		Proteose.		Creatin.	
Lab. No.	Fresh meats.	Desiccated meats.	Fresh meats.	Desiccated meats.	Fresh meats.	Desiccated meats.	Fresh meats.	Desiccated meats.	Fresh meats.	Desiccated meats.
312112	14.27	14.91	3.54	3.05	1.99	1.47	0.107	0.134	...	0.776*a*
312512	14.85	14.74	3.24	2.84	1.68	0.94	0.121	0.217	...	...
313812	14.69	14.67	3.40	2.89	1.68	1.15	0.098	0.110	0.554	0.374
313912	14.48	15.19	2.95	2.75	1.54	1.33	0.058	0.075	0.474	0.539
313312	15.20	15.67	3.73	3.18	2.04	1.36	0.070	0.109	...	0.659*a*
Average	14.70	15.04	3.37	2.94	1.78	1.25	0.091	0.129	0.514	0.456

a Omitted from average.

In order to eliminate the possible influence of the variations in the per-

centage of fat, the data in Table III are presented on the dry and fat-free basis. These results confirm the statements that were made with reference to the relative composition of the fresh and desiccated meats, namely, that the latter samples have a slightly higher per cent. of total nitrogen and of proteose nitrogen, and a lower per cent. of total water-soluble and of heat coagulable nitrogen. The respective average values are: for total nitrogen, 14.70 and 15.04%; for proteose nitrogen, 0.091 and 0.129%; for water-soluble nitrogen, 3.37 and 2.94%, and for the heat coagulable nitrogen, 1.78 and 1.25%.

TABLE VII.—DISTRIBUTION OF THE WATER-SOLUBLE NITROGEN.

Results Expressed in Per cent. of the Total Nitrogen.

	Total soluble.		Coagulable.		Proteose.	
Lab. No.	Fresh meats.	Desiccated meats.	Fresh meats.	Desiccated meats.	Fresh meats.	Desiccated meats.
312112	24.85	20.46	13.91	9.88	0.74	0.90
312512	21.81	19.29	11.28	6.41	0.82	1.47
313812	23.16	19.69	11.40	7.83	0.67	0.75
313912	20.40	18.12	10.64	8.76	0.40	0.49
313312	24.51	20.29	13.43	8.71	0.46	0.70
Average	22.95	19.57	12.13	8.32	0.62	0.86

The distribution of the forms of water-soluble nitrogen in the two series of samples is given in Table VII, expressed in per cent. of the total nitrogen.

From the above data, the total nitrogen of the fresh meats contains a higher per cent. of water-soluble and heat coagulable nitrogen than does that of the desiccated meats, and a lower per cent. of proteose nitrogen. The respective average values are, for soluble nitrogen, 22.95 and 19.57%; for heat coagulable nitrogen, 12.13 and 8.32%; and for proteose nitrogen, 0.62 and 0.86%. In this connection, it should be noted in the case of both the total soluble and coagulable nitrogen, that the highest values in the desiccated meats are no greater than the lowest values in the fresh meats.

Summary and Conclusions.

1. In determining the dry substance in fresh and desiccated beef, the percentage values were higher with the vacuum method than with the heat method at 100–105°. The difference between the two procedures was about 1.9% of the dry substance, as determined by the vacuum method.

2. The percentage of fat (ether-soluble matter) in the dried residues from the heat and the vacuum methods was not influenced apparently by the method of drying. Since the fats, after extraction, were dried in both cases at 100°, there is a possibility that some of the fat from the vacuum-dried samples was volatilized at this stage. The average values were: for the fresh meats 3.12 and 2.98% for the vacuum and heat methods,

respectively, and for the corresponding desiccated samples, 10.28 and 10.04%.

3. Calculating the data for the forms of nitrogen to the dry basis, using the values obtained by the two methods, the results were from 1.2 to 2.0% lower in the case of the vacuum-dried samples.

4. There was no loss of nitrogen upon drying the meats at 100–105°. There was a small loss of nitrogen when the samples were heated at 130°.

5. Comparing the composition of the fresh and desiccated meats, the average percentage fat content of the samples, when calculated to the dry basis was not altered during the desiccation. The respective values were 10.31 and 10.21%. There were, however, distinct individual irregularities in some of the samples.

6. The percentage of total nitrogen in the desiccated meats was slightly higher than in the fresh samples. The respective values were, upon the dry basis, 13.14 and 13.45%, and upon the dry and fat-free basis, 14.70 and 15.04%.

7. The solubility of the nitrogen decreased upon desiccation. The average values for the desiccated meats were 3.01% on the dry basis and 3.48% on the dry and fat-free basis, while the corresponding data for the fresh meats were 2.63 and 2.94%, respectively. Expressing the per cent. of soluble nitrogen in terms of the total nitrogen, the fresh meats had 22.95% of water-soluble nitrogen, and the desiccated meats 19.57%.

8. The percentage of coagulable nitrogen was lowered during desiccation by about 30%. The average values were 1.591 and 1.113%, respectively, for the fresh and dried meats upon the dry basis, and 1.784 and 1.252% upon the dry and fat-free basis. Of the total nitrogen, 12.13% was coagulable in the fresh meats, and 8.32% in the desiccated meats.

9. There was a distinct and significant increase in the percentage of water-soluble proteose nitrogen in the desiccated meats, amounting on the average to 22% of that found in the fresh, undried meats.

Further study is contemplated along this line, and it is the intention to include other meats, differing not only in kind but in degree of fatness.

The authors gladly take this opportunity of expressing their appreciation to Professor Grindley for the helpful suggestions which he offered.

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[3] Grindley and Emmett, THIS JOURNAL, 27, 658.

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NOTE.

Uses of the Concentrated Filament Tungsten Lamp in the Laboratory.— In laboratories where much microscopic work is done, it is frequently necessary, or preferable, to depend upon artificial light; and for this purpose the Welsbach gas lamp seems to be quite generally used, while the Nernst lamp is also used to some extent, with seemingly good results. During the past few months there has been in use in this laboratory, for such work, a stereopticon type of tungsten lamp which has proven so satisfactory as to make it seem probable that a description of it may be of interest to others. The lamp is rated at 100 watts, and probably gives

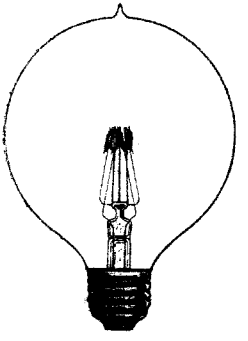

Fig. 1.

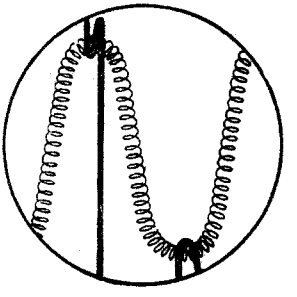

Fig. 2.

about 60 c. p. The filament, instead of being strung out in straight loops between the points of support, is formed into a close coil, which is looped over supports about one centimeter apart (see Fig. 2), and loops forming an open cylinder about one centimeter in diameter. Thus when looked at from the side, the entire light-giving element is concentrated in a space about one centimeter square. The lamp is provided with a round blub about 7.5 cm. in diameter.

The lamp has also been used with the polarimeter for the investigation of the rotatory power of solutions which are too highly colored or which cannot be cleared by the ordinary methods and are too cloudy to transmit sufficient light from the ordinary sources for satisfactory reading. It has the advantage over the ordinary clear bulb tungsten lamp, that no