by both methods of extraction, and as pure anhydrous ether was used it can not be traced to substances of inorganic origin.

To further test the matter two other examinations were made some weeks later of the feces of the same individual, apparently still in normal condition. In these tests the paper coil method was followed, in one case with acidification and in the other case without.

The following figures were obtained.

	Dry. Per cent.	Fat in dry. Per cent.	P_2O_5 in fat. Per cent.	P_2O_5 in dry. Per cent.
1 Acidified	23.4	17.8	1.65	0.294
2 No acid		17.6	1.69	0.298

While these results are lower than before in phosphoric acid content, they are still large from the ordinary standpoint. If calculated as lecithin they correspond to an excretion of about 1 gram daily, on the assumption made above as to total excretion.

The amount of lecithin which may be excreted under pathological conditions, or better the amount of organic phosphorus bodies soluble in ether, is relatively large. The results of Deuscher[1] in this regard are remarkable; in the case of a man with closed pancreatic duct as high as 8 grams of lecithin daily was found in the feces, this amount being calculated from the phosphoric acid of the ether extract. With our present knowledge of the distribution of lecithin in animal and vegetable foods it is somewhat difficult to account for such values, or even for the first ones which I reported above. In view of the lack of agreement on this point it appears likely that further attention should be given to the question of the nature of the organic phosphorus compounds which may be extracted from feces by ether. The assumption that these are all of the character of lecithins may not be justified.

NORTHWESTERN UNIVERSITY, March, 1906.

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NOTES ON TYPEWRITER RIBBONS.

BY A. M. DOYLE.

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IT IS only within comparatively recent years that typewriter

[1] "Jahresbericht über die Fortschritte der Thierchemie," 1898, p. 606; also Schmidt und Strasburger: "Die Faeces des Menschen," p. 160.

machines have been perfected so as to be of practical use. The advantages of such a mechanical contrivance were so great, however, that they were quickly recognized by business men, and the use of the machine has to-day become so general that it has almost completely replaced the old style of longhand writing. Naturally questions have arisen as to the character of the records made, especially as regards permanence. This question was investigated in 1890 by Mr. Thomas Antisell, chemist of the U. S. Patent Office, his results being published in the report of the Commissioner of Public Records of the State of Massachusetts. Other than this report, the writer has been unable to find any literature on the subject of typewriter ribbons.

The Bureau of Chemistry has received requests for information in regard to the character of records made by typewriter ribbons, and these, as well as the need for data to guide in the awarding of contracts, have led the Contracts Laboratory to make the following investigation. The writer is indebted to Mr. L. S. Munson, Chief of the Contracts Laboratory, for many valuable suggestions that were of assistance throughout the work.

Samples were obtained from the Supply Divisions of the various departments and from operators in the Department of Agriculture. The total number of ninety-nine ribbons included fifty-nine new and forty old ribbons representing forty-three brands and nineteen manufacturers. There were 31 record ribbons, mainly black record, and 68 copy ribbons, among which were 30 indelible copy, 11 black copy blue, 12 blue copy, 11 purple copy and four of other kinds.

Operators sending samples of old ribbons were asked to state the length and quality of service rendered by the ribbon, and in this manner information was gathered from a large number of workers. Complaint was made that the ink gummed or smeared; that there was too much ink, clogging the type and making frequent cleaning necessary; that, on the other hand, some ribbons contained an insufficient amount of ink, and therefore did not clog the tpye but were not enduring; that ribbons were unevenly inked, giving spotted writing; that the writing of some ribbons, notably that of the purple copy, faded readily and that the fabric forming the basis of the ribbon wrinkled and stretched along the edges and wore badly in holes.

The length of service as reported varied from less than three weeks to more than seven months, the general idea being that a ribbon should last from six to eight weeks. Very much depends, however, upon the touch of the operator and the action of the machine, as well as the use for which the writing is intended. The amount written by one ribbon was variously reported to be from 264 pages to 2100 pages; the number of words was estimated to be from 109,000 to 630,000, which shows that great differences exist not only in the amount of work done but in the methods of estimating it.

The work of the investigation was conducted along three general lines:

(1) Tests to show the quality of the ribbon fabric—width, total length, weight per square centimeter inked and clean, tensile strength, number of threads in warp and woof and the metric yarn number.

(2) Tests to ascertain the nature of the ink—moisture, ash, lampblack, dye, oil, total inking material and clean ribbon, determining the kind and quantity of each.

(3) Rating of writing and copy on a scale of ten and the action of reagents on the written matter by exposure to sunlight, water, 10 per cent. ammonia, 2 per cent. hydrochloric acid and two-hundredth-normal bleaching-powder.

1. TESTS OF FABRIC.

In the summary which follows the figures were taken from a detailed tabular statement and show the average for each test as well as the variation. The figures for old ribbons in width, length, number of threads and yarn number were about the same as for new ribbons and were, therefore, included among the n.

The varying widths of ribbons adapt them for use on different machines. In all totals, medium width ribbons were included among wide ribbons. In length, wide ribbons varied from nineteen feet to one-half as much more and narrow ones ranged from twenty-nine feet to nearly twice the amount, the averages being 25.5 and 42.8 feet respectively.

Considering the weight per square centimeter, the weight of the inked ribbons, both new and old, varied as much as one-third of the average weight; the weight of the clean ribbons varied

NEW RIBBONS.

Kind of test.	Kind of ribbon.	Number of samples.	Unit of measure.	Variation.	Average.
Width	Wide	61	cm.	3.4 – 3.8	....
	Medium	7		2.4 – 2.6	....
	Narrow	31		1.0 – 1.2	....
Total length	Wide	68	ft.	19.00–28.50	25.50
	Narrow	31		29.50–54.50	42.80
Weight, sq. cm., inked	Record	20	mgm.	8.50–11.76	9.80
	Copy	39		7.26–11.68	9.49
Weight, sq. cm., clean	Record	20	mgm.	5.58–8.76	6.47
	Copy	39		4.79– 7.62	6.15
Tensile strength	Wide	35	lbs.	26.50–50.30	38.80
	Narrow	20		11.70–27.80	20.60
Number of threads	Wide	48	..	48×43–58×56	54×52
	Narrow	28	..	50×49–63×47	59×45
Metric yarn number	Wide	48	..	50– 105	85
	Narrow	28	..	65– 110	85

OLD RIBBONS.

Weight, sq. cm., inked	Record	11	mgm.	8.21–11.37	10.11
	Copy	29		7.55–11.47	9.42
Weight, sq. cm., clean	Record	11	mgm.	5.88– 8.59	7.61
	Copy	29		4.89– 8.23	6.62
Tensile strength	Wide	14	lbs.	16.50–39.10	27.10
	Narrow	6		11.50–22.70	19.50

as much as one-half of the average weight; and these variations were as much or greater than the total amount of the ink, found by taking the difference between the totals for inked and clean ribbons, that is, the average weight of ink was found to be about one-third the weight of the ribbon, and the variation among different ribbons equaled or even exceeded the weight of ink. The average weight of the inked ribbon differed very little whether the ribbon was old or new. The averages for 59 new and 22 old ribbons, eliminating certain abnormal figures which appear in the above totals, were 9.60 and 9.34 mg. per sq. cm. respectively. Inasmuch as all of the old ribbons were reported by operators to be in an exhausted condition, it would appear that the exhaustion of a ribbon depends more upon the wear of the fabric than upon the amount of ink removed. In connection with the

weight per square centimeter, the evenness of the inking was tested by comparing the weights of ten or more sections of the same ribbon. The strips, which were about 35 cm. long, weighed approximately 1 gram, and were found to vary as much as 10 per cent. of the average weight. Shorter lengths would probably have shown greater differences.

The summary which follows shows the variation and averages of the weights per square centimeter for the products of the same factory:

Number of samples from one manufacturer.	Variation, inked ribbon.	Per cent.	Variation, clean ribbon.	Per cent.	Average.	
					Inked.	Clean.
31	7.97–10.02	23	4.93–6.29	23	8.92	5.90
16	8.51–11.68	30	6.08–8.23	30	10.63	7.17
12	8.98–10.74	18	6.18–7.90	25	9.86	6.93
11	8.50–10.75	24	4.96–6.18	21	9.26	5.72

The variation, calculated on the average weight, ranged in the inked ribbon from 18 to 30 per cent. and in the clean ribbon from 21 to 30 per cent. The variation for clean ribbon, therefore, was equal to or greater than that for the inked ribbon, which would seem to show that the ribbon fabric varies rather than the quantity of ink. In the last line, where an exception may be noted, the eleven samples were obtained at the same time from the manufacturer, and there was noticeably less variation in the strength of the material as determined by the tensile strength tests. It is possible, therefore, that a part of the variation may be due to the varying ages of the ribbons, but, aside from this, it is evident that the weight of the material employed by manufacturers is far from being uniform.

The figures for tensile strength represent each an average of at least ten, frequently twelve or fifteen determinations. One inch of the ribbon was tested at a time and so great were the differences between sections that a fair average was obtained only by a large number of tests. Many of the ribbons showed differences of as much as seven and one-half pounds in successive tests on the same ribbon, while the maximum difference for the same ribbon was twelve pounds. Comparing different ribbons, some bore fully twice the strain of others in the same class. Old ribbons, as might be expected, were of less strength, the total difference being marked in the case of wide ribbons but obscured in the total for narrow ribbons because of the presence of selvage.

The number of threads, warp and woof, and the metric yarn number were ascertained by Mr. B. J. Howard, Chief of the Microscopic Laboratory. The number of threads, which were directly counted under a microscope with micrometer attachment, together with the weight per square centimeter of the clean ribbon, gave the yarn number, according to a formula worked out by Herzfeld.[1] The number of threads, yarn number and tensile strength would naturally be closely related but the results did not establish such relation, possibly because the date of manufacture was not considered. Ribbons may become weak and even fall to pieces in time, owing to the presence of corrosive materials in the ink, and it is, therefore, probable that the apparent lack of agreement in the three sets of figures is due to the fact that the ribbons had been on hand for a greater or less length of time.

2. TESTS OF INK.

Kind of test.	Number of samples. New.	Old.	Variation, both new and old. Per cent.	Average. New. Per cent.	Old. Per cent.	Total. Per cent.
Moisture, or matter volatile at 100° C..	59	40	2.67– 6.06	4.28	3.68	4.05
Ash.....	58	22	0.43–15.24	2.48	1.82	2.27
Lampblack, record..	18	8	0.88– 7.00	3.18	2.32	3.03
Lampblack, copy.....	22	18	0.25– 3.44	1.57	1.54	1.56
Dye.....	31	...	3.34– 9.26	5.85	.....	5.85
Oil.....	59	22	15.43–31.02	22.09	19.40	21.26
Total ink.....	58	40	20.56–46.00	34.78	28.42	33.38
Clean ribbon.....	58	40	79.44–54.00	65.22	71.58	66.62

In the summary of the tests for the ink, the averages for the new and old ribbons were separated, but the variation differences were not great enough to make two statements necessary. In all of the tests the variation among ribbons, both new and old, was very wide. The volatile matter, determined by heating to constant weight at 100° C., averaged about six-tenths lower in old ribbons, showed practically no variation from day to day, but lessened gradually as the ribbon aged. The ash, which was determined by burning off carbonaceous matter at a low red heat, varied in general between 1 and 2 per cent. From 3 to 5 per cent. is a high ash content, and above 5 per cent. is very unusual. The kind and quantity of ash give valuable indications of the coloring-matter used for the ink.

[1] See "Yarns and Textile Fabrics."

The determination of the lampblack was very difficult because it was almost impossible to separate it from the fibres of the ribbon. Of the several methods tried, but two gave any measure of success and these agreed only within two or three-tenths of a per cent. In one method the cotton material was dissolved away by strong sulphuric acid, and the resulting solution passed through a Gooch filter which retained the lampblack. The other method consisted in separating the lampblack mechanically, in ethereal and alcoholic solution, by shaking and rubbing, the carbon being collected on a Gooch crucible. The latter method allowed of a direct weighing of the cotton skeleton of the ribbon and for this reason was the preferred method. All of the black record, black-copy-blue and indelible copy ribbons contained lampblack, copy ribbons averaging about 1.5 per cent., and record ribbons about twice as much.

On treating the ribbon with ether to extract the oil and filtering through a Gooch crucible, it frequently happened that the dye, as well as the carbon, was filtered out. After removal of all of the oil by ether, the ribbon and crucible were both dried and weighed. They were then treated with alcohol and water, and sometimes strong acid, which removed the dye, and, after drying and again weighing, the dye was found by difference. This method gave excellent results. Methylene blue, which was very commonly used, was determined by titration with a standard solution of Krystal Ponceau, according to a method worked out by E. Pelet and V. Garuti, published in the *Bulletin de la Soc. Chim. de Paris.* Duplicate tests agreed within 0.05 per cent. The summary gives the results of 31 determinations of methylene blue made by this method.

The oil was determined by extraction with ether and direct weighing. The amount of oil, which appears to influence the working qualities materially, averaged about 22 per cent. Much less shortens the life of the ribbon, and much more clogs the type and makes the writing blurred, while the length of service is not correspondingly increased.

The figures for total writing material equal the difference between 100 per cent. and the total clean ribbon. Not a very close relation seems to exist between total ink and ribbon efficiency, although as a rule those ribbons having high working qualities possessed more than the average amount of ink, made up of more

than average content of oil and dye. The total ink of ribbons of a popular make ranged from 27 to 38 per cent., showing that wide variation is possible in ribbons giving general satisfaction. Ribbons of much less than average ink may possess good working qualities for a time but they do not last well. Those with low percentage of either dye or oil seldom work well and low amounts of lampblack detract from the permanence of the writing. The percentage of available ink was roughly determined by taking short pieces of the ribbons, weighing, using to the point of exhaustion and again weighing. Of the 27 ribbons thus treated, the loss ranged from 1.8 per cent. to 16.5 per cent. with an average of 8.0 per cent. calculated on the actual space exhausted. This agrees very well with an average loss of about 6 per cent. of the total ribbon, shown in the summary of tests. The ribbons yielding the greatest amount of available ink, in the above test, did not as a rule give a larger amount of writing, but rather showed a tendency to clog the type and blur the writing, showing that the ink flowed too freely. One ribbon wrote twice the number of lines that any other ribbon was able to do, and contained 13.5 per cent. of available ink. This ribbon contained high percentages of moisture and of dye but only average amounts of the other ingredients. It is to be regretted that but one of this make of ribbon was examined.

3. TESTS OF WRITING.

In the rating of the writing and the copy, the best was assumed as a standard, ranked one, and the other figures up to ten show a gradation from clear, strong impressions to writing that is barely legible. The effect of reagents was also rated on a scale of ten, ranging from one, or "unaffected" to ten, or "completely effaced." In all of the tests the uncopied writing, the copied writing and the copy were similarly treated. The sunlight test, which was very severe, consisted in exposing the three kinds of writing, under glass, to the direct rays of the sun for ten days. Very weak solutions of the wet reagents were employed, but these, too, proved to be rather severe when applied for twenty-four hours. In a general way it was found that in treatment with reagents the original writing was severely attacked, the copied writing was less so and the copy was completely effaced. With few exceptions record ribbons furnished permanent records and the

original writing of those copy ribbons that contained lampblack was permanent, but the copies were not. Copy ribbons failed to give indelible copies because almost none of the carbon was transferred. On exposure of the copy to sunlight for ten days or less, the dye faded out completely, leaving the writing illegible. Most of the ribbons were very satisfactory when fresh, both the original and the press copy being good, but marked differences in the quality of the records were developed by wear, a number which gave good results at first being quickly exhausted.

From the foregoing it may be seen that ribbons of different makes differ widely in their properties; that ribbons of the same make differ as widely; that the ribbon itself is of uneven construction; that the fabric, more than the ink, is the cause of these variations; that many record ribbons furnish permanent records and that much is yet to be desired in the attainment of truly indelible copy ribbons. It is evident that there is need for definite requirements to regulate the purchase of typewriter ribbons, especially as regards the material which is employed as a basis for the ink. An essential of a good ribbon is that the fabric be of the quality best fitted to endure the special kind of service required until all ink available for good writing is exhausted.

AN ANALYSIS OF THE WATER OF DEATH GULCH.

BY G. B. FRANKFORTER.

Received February 7, 1906.

PROBABLY no other spot of the same area in the whole world furnishes such a wealth of natural waters as our Yellowstone National Park. Within its bounds may be found waters containing carbonic acid gas, silicic, boric, sulphuric, hydrosulphuric and even free hydrochloric acid, in addition to salts of nearly all of the metals ever found in any natural water.

One of the most remarkable waters in the park is that of the little stream which flows down through a narrow ravine into Cache Creek. This ravine is now known as Death Gulch. It was discovered by Walter H. Weed in 1888 while exploring for the United States Geological Survey and fully described by him in *Science*. In 1898 it was visited by Dr. Jaggar who found in the gulch the remains of a number of animals including seven