CEW:HA
V-3

DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS
WASHINGTON

Letter Circular LC 597

June 11, 1940

CARBON PAPER AND TYPEWRITER RIBBONS

This letter circular has been written to give some general information on the manufacture of carbon paper and typewriter ribbons, and to describe the methods of testing in greater detail than is possible in an ordinary letter. By following the instructions any careful person can make comparative tests of samples of different brands on an ordinary typewriter, and will then be able to form an opinion as to their relative merits for the work to be done.

The National Bureau of Standards often receives letters that ask for information about carbon paper and typewriter ribbons. Some of the writers ask what are the best brands to buy. The Bureau can not possibly keep fully informed about the relative merits of all the brands of carbon paper and ribbons that are on the market. To say that any given brand of either material is the best might be untrue, because the statement would be based upon incomplete information. Correspondents who ask what to buy are advised to do their own testing and to decide for themselves.

General

Very little published information on the manufacture of carbon paper and typewriter ribbons can be found. This is especially true of formulas for the ink used in the ribbons, and for the coating (also called "ink" by the manufacturer) on the paper. The books of formulas to be found in every public library tell how to make these materials. The reader is told to mix the ingredients, though simple mixing will not as a rule make a satisfactory product. The materials must be ground together in a suitable mill, in order to disperse the particles of pigment, or solid coloring matter, throughout the vehicle (the more or less liquid part) of the ink. Fine-grained as it looks, carbon black is made up of clumps of much finer particles clinging together. Grinding the ink mixture separates the particles from one another and coats them with the vehicle, so that new clumps will not be formed. Stirring the mixture will not break up the clumps, nor is this easy to accomplish by hand-grinding with a mortar and pestle. If by dint of persistent grinding by hand some patient person succeeds in making a proper ink or coating, he is confronted with the problem of spreading it by hand, uniformly and in the right quantity, upon the ribbon fabric or the paper tissue. It is safe to say that the finished product, whether a typewriter ribbon or a sheet of carbon paper, will not be equal in quality to the cheapest kind that can be bought.

Some of the producers sell carbon black that can be used directly, without the necessity of grinding it. The carbon is in the form of a solid or semisolid paste, which has evidently been thoroughly ground with special "dispersing agents" or "protective colloids." Whichever it is called, the name simply means that the special admixed material makes the particles of carbon black disperse readily through a liquid and remain a long time in this condition without settling to the bottom.

Manufacture and Properties of Carbon Paper

The formulas for making carbon paper, which are given in nearly all the books of formulas referred to, are evidently for the soft pencil-carbon coating, and not for the relatively hard coating generally used for typewriting. The following formula taken from a German chemical journal is for pencil carbon. In this, as in the other formulas given in this letter circular, all the ingredients are in parts by weight.

> Grind together 10 parts of carbon black and 40 parts of paraffin oil or other mineral oil. Add 1 2/3 parts of nigrosine base dissolved in 3 1/3 parts of oleic acid (commercial red oil); and finally add 40 parts of paraffin or ceresin dissolved in 30 parts of oil at 40° to 50°C (104° to 122°F). Grind again and spread while at 40° to 50°C.

The large proportion of oil and the absence of carnauba wax and other waxes that are harder than ceresin show that this formula will make a coating softer than that customary for typewriter carbon paper. The degree of hardness of this coating will depend upon the softness of the paraffin (as measured by its melting point), and whether paraffin or the somewhat harder ceresin is used.

H. Bennett (Chemical Formulary, vol. 4, p. 148, Chemical Publishing Co., New York, 1939) gives two formulas taken from Austrian Patent 148,997:

	(1)	(2)
Carnauba wax	9	31
Montan wax	6	24
Violet dye	7	7
Mineral oil	63	23
Lampblack	15	15
	100	100

Evidently one of these will make a hard coating, and the other a soft one.

Bennett gives other formulas in the Formulary and in his other book, Practical Everyday Chemistry. More formulas, all for soft coatings, are in Jameson's Manufacturers Practical Recipes (Lewis Jameson & Co., Ltd., London, 1929).

Each manufacturer makes paper with hard, medium, and soft coatings, and with different surface finishes, as glossy and mat, or dull. There are no generally recognized standards for the degrees of hardness, but each manufacturer has his own. It is evident, considering formula (1) from the Austrian patent, that by increasing the amount of carnauba wax in steps of 1 percent, and decreasing the mineral oil by the same amount, 21 coatings slightly different in hardness could be prepared between (1) and (2). Some of the commercial coatings are so soft that copies made with them smear badly when erasures are made, or merely by handling. Other coatings are so hard, and so slightly adherent to the paper, that they flake off when the paper is crumpled.

The hardness and surface finish of the carbon paper to a great extent determine its suitability for a given class of work, though there are several other factors that affect the results. Among these are the thickness and stiffness of the first and copy sheets, the thickness of the carbon paper, the number of manifild copies to be made, the size of the type, the characteristics of the typewriting machine, and the touch of the operator. If only one to three manifold carbon copies are to be made at one time, a hard finish is best, because it gives sharper copies, wears off more slowly, and has less of a tendency to smudge than the softer finishes. On the other hand, if a large number of copies must be made at one time, and the blow of the type will have to be transmitted through many layers of paper, carbon paper with a soft coating is needed. Because there is no convenient, accurate method for measuring the hardness of the coating on carbon paper, the best way to ascertain its suitability for a particular class of work is to make the writing tests described further on.

An interesting fact in connection with the coating of carbon paper is that for a period of several weeks after it has been applied it gradually improves in writing quality. Nobody seems to know why this should happen, but the fact can not be disputed. This Bureau has tested carbon paper and reported that it did not quite meet the requirements for "wear-down." A few weeks later, when a retest has been made at the request of the manufacturer, the sample has improved enough to be passed. Some manufacturers think that the improvement is caused by some of the oil in the coating being absorbed by the paper. According to others it is due to the "setting" -- possibly crystallization -- of some of the constituents of the coating. After a much longer time the coating deteriorates and the carbon paper will not make good copies. This Bureau has kept samples for six years, that still did satisfactory work. According to an English manufacturer (Morland & Impey Ltd., Birmingham, England), "there appears to be a minimum limit of about 4 grammes [per square meter of paper] below which bad ageing qualities are almost certain, irrespective of the nature of the coating. On the other hand, we have found that coatings above 10 grammes appear to be the least affected by the passage of time." No American manufacturer has ever suggested to this Bureau that there is any relation between the weight of the coating and the aging qualities of carbon paper.

One of the factors that have an effect upon the copying qualities is the thickness of the carbon paper. In practice the thickness is stated in terms of the weight of the uncoated paper tissue. This is sometimes expressed as the weight of 500 sheets, 20 by 30 inches. For instance, if a box of carbon paper is marked "4-lb", it means that the uncoated paper is supposed to weigh 4 pounds per 500 sheets of the size 20 by 30 inches. Actually the paper is rarely so light in weight as this, but is more apt to weigh from 4.3 to 4.8 pounds, or even a little more. In the Federal Specification for light-weight carbon paper, the maximum permissible weight of 1000 decoated sheets is 10.0 lbs. Seldom indeed is the weight below 4 pounds, though the Bureau has a record of 3.6 pounds for one sample. The tissues of the numerous grades of carbon paper intended for different uses range in weight from these so-called "4-lb" papers up to about 18 pounds, which is the weight of pencil carbon .

The 4-pound and other light papers are generally made of rags or of manila, jute or hemp stock, considered equal to cotton rags , in order to secure the necessary compactness and strength. The heavier papers are composed wholly or in part of woodpulp. For this reason, and because it is easier to make a thick paper than a thin one, the relatively heavy tissues are cheaper than the lighter ones. According to the manufacturers, some types of paper are harder to coat than others.

The machine for coating the paper has a series of steel rolls, some of which must be hot, while the others may be heated or cooled as desired. One of the rolls picks up a supply of the melted "ink" from a reservoir and applies it to the paper, which then passes between a heated roll and a rod on which a wire is closely wound over its entire length. This rod removes the excess of coating. The depth of the groove between two adjacent turns depends upon the diameter of the wire, and thus the amount of coating left on the paper is controlled by selecting a wire of appropriate size. The object of the succeeding rolls is to make a coating of uniform thickness and with a smooth surface over the entire width of the long roll of paper. The finished carbon paper is cut to the desired sizes and packed.

Manufacture of Typewriter Ribbons

Published formulas for the ink in typewriter ribbons are as scarce as formulas for the coating on carbon paper. A German formula for black ink is, in parts by weight:

> Grind together 10 parts of carbon black and 40 parts of petrolatum. Add 1 2/3 parts of nigrosine base dissolved in 3 1/3 parts of oleic acid ("red oil"), and again grind.

For colored ribbons, various dye lakes and other pigments are used instead of carbon black. Of course the nigrosine dye is omitted, but sometimes other oil-soluble dyes are employed instead.

A formula found in the American Ink Maker, January, 1939, is as follows:

> Dissolve 1 1/2 lbs. of methyl violet base and 1 lb. of alkali blue toner in 16 lbs. of commercial oleic acid, at as low a temperature as possible. With this solution mix 5 lbs. of high-grade free-flowing carbon black and 2 lbs. of No. 20 S.A.E. motor oil. Run several times through a highspeed 3- to 5-roller ink mill until the ink is fine and smooth.

Still other formulas are given by Bennett and Jameson in the three books cited in connection with carbon paper.

Copying ribbons, for making copies in a letterpress, contain water-soluble dyes as part of the pigment. In spite of the oil in the ink, these dyes dissolve sufficiently to make copies. Although they have bright colors when dissolved in water, many dyes are dark brown powders which mix easily with carbon black. This makes it possible to have ribbons that give black writing from which copies in blue or some other bright color can be obtained.

For hectograph ribbons the ink is water-soluble, and heavily loaded with a dye of great color strength. This is nearly always methyl violet, crystal violet, or a closely related dye.

The ribbon fabric is almost always cotton, but silk ribbons are also made for those who wish especially sharp writing, made possible by the thinness of the silk. Rayon, which can be as thin as silk and is much cheaper, has of course been experimented with, but manufacturers who have visited the Bureau have said that it is very hard to ink rayon properly. One ribbon manufacturer claims to have overcome the difficulties.

The fabric is woven about 42 inches wide, and is sold in lengths of about 144 yards. Before being inked it is put through a finishing process, which includes singeing to remove the ends of fibers projecting from the surface. Sometimes it is stretched and compressed between rollers, though one manufacturer of ribbons is opposed to this treatment because it weakens the fabric. The last steps before the inking are to cut the fabric into strips of the width required for the ribbons, and to gum the edges to prevent fraying in the typewriter. Some special ribbons are woven to the required width, so they have selvages, which do not need to be gummed.

The thickness of ribbons for typewriters is in the neighborhood of 0.005 inch, with a variation of a few ten-thousandths of an inch below or above this figure. Some special ribbons for computing and recording machines are as much as 0.0067 inch in thickness, because of the hard service conditions. In selling ribbons, the thread count, or number of threads per inch, is stressed, though not much is said about the thickness. In giving the thread count, sometimes the numbers of warp and filling threads per inch are given separately; for instance, warp, 152, filling, 150. Perhaps because it makes the fabric seem more finely woven, many prefer to add the two figures and to say that the thread count is 302. The Federal Specification for typewriter ribbons requires that there shall not be fewer than 148 threads per inch in either direction, and that the sum of the two counts shall not be less than 300. Much higher counts than this are possible, for one sample of fabric sent to this Bureau had a count of 160 in one direction and 256 in the other, a total of 416. The lower of the two counts shows which are the filling threads, each of which requires a separate throw of the shuttle during the weaving. The fewer of them there are in an inch, the greater the yardage that can be woven in a given time. The time factor, which affects the cost, is of greater importance in weaving a selvage ribbon 1/2 inch wide than it is in weaving fabric that is 42 inches in width. For this reason the filling count of selvage ribbons is often as low as 110 threads to an inch.

In theory, if not in practice, it is best for the two counts to be nearly alike. The argument is that when the ink is exhausted to such an extent that the impressions made on paper are not continuous lines but series of dots, the writing will look less spotty if the counts are nearly equal, than if they differ by 20 or 30 threads to the inch.

The inking machine has a series of rolls, adjusted to apply uniformly the right quantity of ink. Aside from the manufacturer's ideas, whether a ribbon has light, medium, or heavy inking depends upon the amount of ink applied to the fabric, the fluidity of the ink, and the characteristics of the fabric. After the inking operation, the long strip of fabric is measured and cut into lengths by machine. The metal parts are attached to the ends of the ribbon, and it is then wound upon a spool, wrapped and boxed.

Brief accounts of the manufacture of carbon paper and ribbons are given by C. A. Mitchell in his book, Inks, Their Composition and Manufacture (J.B.Lippincott Co., Philadelphia and New York, 1937). Those who read German and can get hold of the book will find something about typewriter ribbons under the heading "Schreibmaschinenfarben" in the article "Tinte", in F. Ullmann's Enzyklopaedie der technischen Chemie, 2nd ed. 10, 9-11 (Urban & Schwarzenberg, Berlin and Vienna, 1932). In Chemical Abstracts there are a few scattered references to patents or published articles. See also C. J. West, Bibliography of Paper Making (Lockwood Trade Journal Co., Inc., New York), for references on carbon paper.

Testing Carbon Paper

The ordinary user makes only one, or sometimes two or three, carbon copies of what he writes, but sometimes it is required that the carbon paper will make 10, 12, or even 15 good copies at one time. In addition, it should be possible to use a sheet of carbon paper a considerable number of times before the coating is worn off. The writing tests in the Federal Specifications are intended to find out whether the carbon paper meets these requirements. For years the testing was done on an ordinary, or standard, typewriter, but the present specifications require the use of an Electromatic typewriter, because the force with which the type hit the paper can be controlled by the speed at which the power cylinder of the machine turns. When making a number of copies at one time, a hard blow of the type is needed, and the power cylinder is set at speed 8. A light blow, at speed 7, is used for making the wear-down test, to find out how many lines can be writteh with exactly the same part of the carbon paper. It is easy for anyone who has a reasonably uniform touch to make the tests on a standard typewriter, and to decide for himself which of a number of samples of carbon paper gives the best results. The sharpness and clearness of carbon copies depend to a considerable extent upon the thickness and stiffness of the first and copy sheets, so that there is an advantage in making tests under actual service conditions.

Wear-down Test.-- The wear-down test is often called the serviceability test, though this is too broad a name for it, because serviceability implies other things than the power to write a large number of lines, which is all that the test is intended to show. The test is made in the following way:

From a new sheet of carbon paper cut a piece about 1 by 2 inches and, by means of a strip of gummed paper or of Scotch tape across each end, fasten it with the coated side out to a sheet of the letter paper with which it is to be used. Place this, together with a sheet of the usual copy paper, in the typewriter. Then by means of paper clips, pins, or in some other way, fasten the first sheet to the back of the carriage, so that the first sheet carrying the sample will not move when the platen, or roller, is turned to shift the copy sheet from one line to the next. Before starting to write, give the platen a slight turn so as to pull the first sheet taut. It is advisable to so set the lever which moves the paper release bar that the paper is not pressed against the platen. When this is done, there is less likelihood that the carbon paper will move when the copy sheet is shifted from one line to the next.

Now write the letter g, or any other letter with small loops, 10 or 12 times. Use the same light, uniform touch for this and all the lines that follow. Shift the copy sheet a line by turning the platen, and write the same number of g's over the same place as before. Repeat this until 15 or 20 lines have been written, and then examine the copy sheet. The lines should gradually grow paler, from one line to the next. The more lines of reasonably good intensity of color, the better the serviceability of the sample. Sometimes the first sheet carrying the carbon paper moves a very little during the test, or the machine may be worn, so that the type-bar has a little play and the type does not always hit in exactly the same place. If, for instance, the carbon paper shifts a little to the right, each g will have its lines blacker at the left. If the type hits to the right, the black edges will be at the right. In either case the reason is that a narrow band of the carbon coating that has not been hit by the type now contributes to the blackness of the letter. The presence of black edges to the g's should not mislead the person who is making the test.

If a sample of carbon paper makes, say, 15 good copies in the wear-down test, it should be possible to use a sheet of it more than that number of times in actual service. When the sheet is put in the machine the second and succeeding times, it is always in a slightly different position with respect to the type. Also, each time the sheet is used the words are different. As a result, when a sheet of carbon paper is finally worn out, comparatively little of its surface has escaped doing its share of the work. It is then very different in appearance from the exhausted test piece, which shows the g's as transparencies. The almost complete removal of the coating, wherever it is hit by the type the first time a sheet of carbon paper is used, is sometimes called "stenciling."

The Federal Specification for standard-weight carbon paper requires that it "shall make not fewer than 15 clean, legible, first carbon copies of good intensity" in the wear-down test, with the Electromatic typewriter set at speed 7. The tissue for light-weight paper will not carry so heavy a coating, and only 12 satisfactory lines are required of it.

Manifolding Test.-- The Federal Specifications for carbon paper require that the standard-weight paper shall make at one time 5 good, legible manifold copies, while the light-weight paper shall make 10 copies. Assemble in the usual way an ordinary first sheet of letter paper and either 5 or 10 thin manifold or copy sheets and the same number of sheets of the carbon paper under test. Insert in the typewriter and write, in unrelated order and twice over, all the capitals, small letters, and numerals. The stroke should be rather heavy, and as uniform as possible. The Electromatic typewriter is set at speed 8 when making this test, unless the carbon paper is especially for use on a noiseless typewriter. In that case, according to amendments to the Federal Specifications, the speed is to be 7, and there must be made 6 or 12 manifold copies, instead of the 5 or 10 made with carbon paper for use on standard typewriters. These changes are made because the noiseless machines in general are not set for heavy blows of the type.

The last manifold sheet is examined for legibility and for intensity of color of the impressions. There should be no illegible numerals, and of the 104 letters, not more than 3 should be illegible if the carbon paper is standard-weight, nor more than 4 if it is light-weight. These requirements are for tests made on an Electromatic typewriter with pica type. They would have to be less severe with the smaller elite type, or if heavier first and copy sheets are used instread of those required in the specifications.

Obviously a copy with illegible numerals would not be satisfactory. The small tolerances of 3 or 4 illegible letters do not seem unreasonable, because words and sentences can be read when a much larger proportion of the letters are so blurred that they can not be recognized. This is shown by the sentence below, in which a hyphen takes the place of every sixth letter (about 17 in 104). It would be still easier to read if there were blurred letters, some low and others tall, to give the reader clues. For instance, the shape of the blur would show whether -een is been or seen.

> Manuf-cture-s of ca-bon pa-er, who-e opin-on has -een as-ed, agr-e that -he leg-bilit- test h-re des-ribed -s more -evere -han a t-st in w-ich mo-e copi-s are m-de, but -n whic- words -r a sho-t sent-nce is -ritte-.

Pencil-Carbon Paper.-- There is no Federal Specification for pencil-carbon paper, but one of the Government Departments has its own specification, which tells how it shall be tested. Because of the way it is used, this kind of carbon paper has a soft coating on rather heavy paper. A sheet of it is laid, coated side down, on a sheet of white paper. Near the top of the sheet a word is written with a sharp No. 4 lead pencil. The carbon paper is moved down about half an inch, and the word is again written, with the pencil following exactly the strokes of the first writing. This is repeated until the word has been written 20 times over exactly the same part of the carbon paper. If the writer does not bear too heavily upon the pencil, good carbon paper will make 20 good, legible copies.

It is not easy to follow the strokes exactly when writing the 20 copies, and there are always irregular variations in the pressure of the pencil against the paper. For these reasons the Bureau has been making the test by ruling straight lines with a weighted pencil held by a simple device. Two sets of lines are drawn, one with a total weight of 150 grams (5.3 avoir. oz.) and the other with 450 grams (1 avoir. lb.). The quality of the carbon paper is judged by the intensity and sharpness of the 20 lines drawn.

Fiber Composition and Weight.-- Determinations of the fiber composition and weight of the paper tissue can not be made without laboratory facilities, but fortunately they do not have such a direct bearing upon the writing qualities of the carbon paper as the tests that have been described. The coating must first be removed with carbon tetrachloride, benzene (benzol), or other suitable solvent, aided by gently scrubbing. An apparatus for removing the coating was devised by the Bureau. (See Paper Trade Journal, 80, 53 (Mar. 19, 1925); 95,34 (Oct. 20, 1932)). The cleaned paper is dried to remove the solvent, "conditioned" in a room that is kept at a definite atmospheric humidity and temperature, and finally weighed and measured. From the weight and dimensions of the few sheets used for making the test, the weight of 1000 sheets, 20 by 30 inches, is calculated.

Portions of the decoated tissue are examined microscopically to determine the fiber composition. The methods, which need not be described here, depend upon the characteristic appearance of the fibers and their behavior towards certain staining agents.

Testing Typewriter Ribbons

The writing qualities of a typewriter ribbon are determined by wear-down, recovery, and type-filling tests. It is customary also to get the thread count and to measure the thickness. These two may be of importance in a specification, but the writing tests give practical information about the combination of ink and fabric, which is what the actual user of the ribbon is interested in.

Wear-down and Recovery Tests.-- The number of lines that can be written over the same short length of a ribbon is known as the wear-down, or less correctly, the serviceability. In the Federal Specification it serves to define the degree of inking of the ribbon, as will be seen further along. To make the test, unwind about a yard of the ribbon, so as to get to a fresh portion, and lay the spool at one side of the Electromatic or other typewriter, with the end of the ribbon across the machine. With paper clips or other suitable means, fasten the ribbon to opposite sides of the carriage, under enough tension (about 50 grams) to permit writing, without too much slackness of the ribbon. The ribbon should be adjusted so that the type will strike it near the middle, and not close to the edge. If it is a two-color ribbon, the type should strike the middle of the colored part being tested. The writing is done on a sheet of paper at least 21 inches long or, if this size is not available, on a piece of that length made by pasting two letter-size sheets together end to end. It is not satisfactory to omit the pasting and to insert one sheet after the other, because during this operation there will be some "recovery" in the ribbon, and possibly some shifting of its position, whereby the test will be spoiled. With the Electromatic typewriter set at speed 8, a line of about 30 capital B's, K's, or R's is written near the upper end of the paper. The carriage is pushed back to the starting point, the paper is shifted a single-spaced line, and the same letters are again typed over exactly the same part of the ribbon as before. This is repeated without stopping until the required number of lines have been written. The ribbon is allowed to remain undisturbed for 20 minutes, after which one more line is written.

The last line written shows the amount of "recovery", or flow of ink in the fabric. This flow starts as soon as the ink is partly removed from any portion of the ribbon when typing, so the wear-down test will not give strictly comparable results with two or more ribbons unless it is carried to completion for each without delays and within the same length of time. To avoid the necessity of stopping to count, each line that is an odd multiple of 5 can be marked by typing one or two extra letters at the right, and the lines that are multiples of 10 can be marked with three or four extra letters. Anybody can tell without stopping when 5 lines have been written, and it takes but a fraction of a second to type the extra letters.

The Federal Specification defines the degrees of inking of ribbons by the number of lines of good intensity that can be written in the wear-down test. A heavily inked ribbon should write 100 lines, a medium-inked ribbon, 75 lines, and a lightly inked one, 50 lines. The recovery lines of ribbons of the three inkings shall be no paler than lines 75, 60, and 40, respectively, in the wear-down. Because the ink in bicolor ribbons is in general less fluid than that of single-color ribbons, the specification treats bicolor ribbons in all respects like lightly inked single-color ribbons.

Too many manufacturers try to improve the recovery by making ink which contains too little carbon black, but with an increased proportion of dissolved dye. The result is that within 24 hours after writing with a new ribbon, the back of the paper is more or less stained by ink that has penetrated it. Sometimes when the paper is held up against the light a clear zone can be seen around each of the characters. This is caused by the excess of oil spreading slightly and making the paper more transparent. Because the clear zone is at most yellowish, it seems evident that the dye has been held by the paper, and does not stay in solution in the oleic acid and other oily material in the ink. This is not surprising, because the dye is a colloid, and is susceptible of being adsorbed by the paper.

Permanence.-- The permanence of typewriting depends upon the carbon in the ink, because this can not fade, while dyes eventually disappear. When the writing is exposed to light, it will become brownish, but will be no paler, unless the ink contains too little carbon black and too much dye in proportion. A brownish tint is natural to carbon black when in a thin layer. The use of dyes, or "toners", in the ink is to mask this brown color on the same principle as the use of bluing when laundering linen, to make it look white, instead of yellowish. If the ink is too oily, there is not enough carbon black in the impressions, and the lines on the lower half of the wear-down sheet have a bluish or purplish tone, and there will be marked fading on exposure to light. According to the Federal Specification, such ribbons are not acceptable. In the laboratory the fading test is made with a carbon-arc lamp designed for the purpose. It is more dependable than sunlight. Comparative tests can be made by exposing the writing to direct sunlight (not behind glass) for several days. A piece about 2 1/8 by 2 3/4 inches is cut from the wear-down sheet, so as to include parts of lines 5 to 15. After the required exposure to light this piece is fitted back into place, and any fading can be detected easily, by comparison with the parts of the lines that have not been exposed.

If the writing of lines 5 to 15 fades badly, the ribbon should not be used for writing that is to be kept for many years. Even the best of ribbons should not be used, for permanent records, when enough of the ink has been exhausted to make the writing noticeably pale. Red, blue, and other colors than black may last several decades if kept in the dark most of the time, but carbon should last as long as the paper holds together.

Type-Filling.-- Some ribbons have a tendency to clog or fill the type, particularly o's, g's and similar letters with small loops. The filling material is a mixture of ink and lint from the fabric. To test for this fault, the ribbon is allowed to move in the regular way when typing, and the letter e is written 800 times. All the impressions should be clear, with no evidence of filling the type. Clogged type can be cleaned by brushing with a toothbrush or, better, by wiping with a rag or a wad of absorbent cotton moistened with gasoline, benzene (benzol), or the less dangerous carbon tetrachloride.

Nonuniform Inking.-- The complaint is sometimes made that ribbons are not evenly inked. Sometimes the complaint is backed up by a display of writing in which pale letters are scattered among much blacker ones. As a rule the writing has been done with a ribbon from which much of the ink has been exhausted. It is probable that the so-called uneven inking is really due to the uneven tough of the typist, which becomes more apparent when the ink is becoming exhausted. Because of the way the fabric is inked, and the travel of the ink in the fabric, it is unlikely that the alternation of dark and pale letters can be caused by uneven inking within the space of a few inches.

Federal Specifications.-- The Federal Specifications for carbon paper and ribbons are sold by the Superintendent of Documents, Government Printing Office, Washington, D. C., for 5 cents apiece. Payment should be made by postal money order, express order, or New York draft, payable to the Superintendent of Documents. Postage stamps should not be sent, and money is at the sender's risk. Payment can also be made by coupons sold by the Superintendent of Documents at $1 for 20. They are good until used.

The specifications are designated as follows:

DDD-R-271, Ribbons; Computing and Recording Machine.
DDD-R-291, Ribbons; Hectograph.
DDD-R-311a, Ribbons; Typewriter.
UU-P-151a, Paper; Carbon, Light-weight (Typewriter), Black.
UU-P-156a, Paper; Carbon, Standard-weight (Typewriter), Black.