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TESTS OF FLEXIBLE GAS TUBING

BY

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and

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WITH A REPORT ON GAS-TUBING INSPECTION IN NEWARK, N. J.
BY ELLSWORTH FRANCISCO, INSPECTOR OF GAS AND
GAS METERS, NEWARK, N. J.

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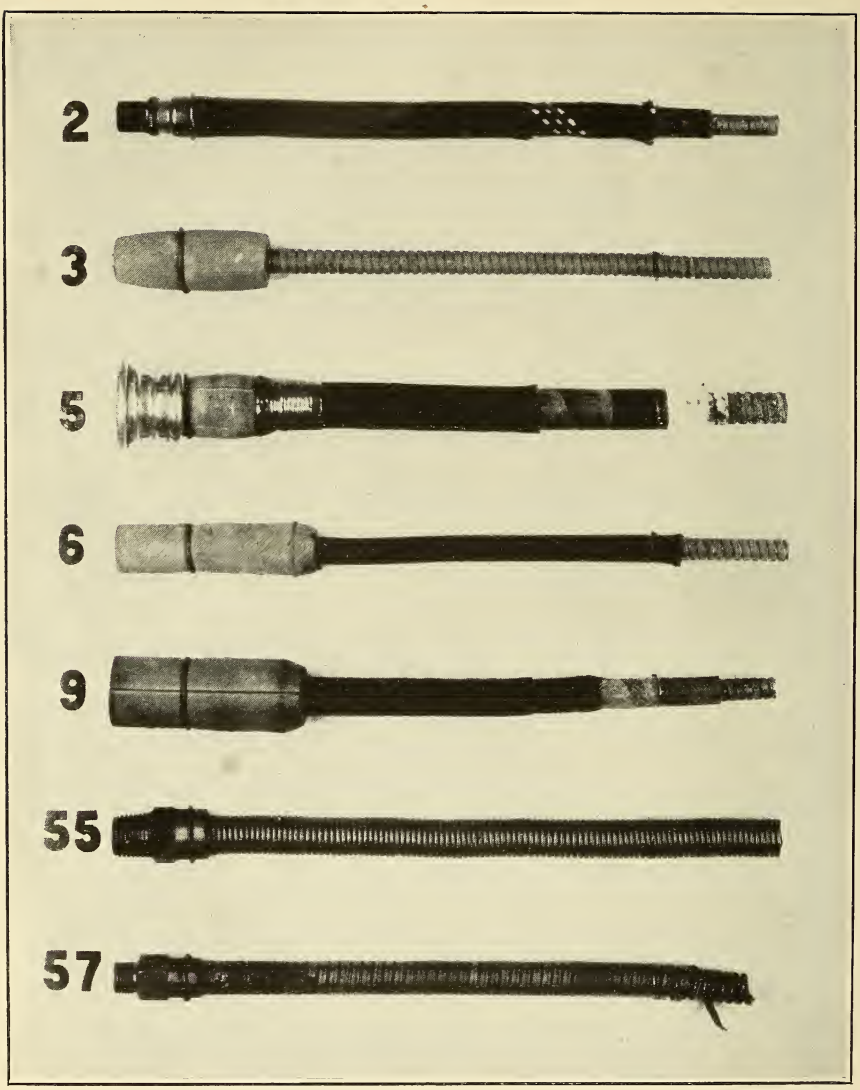

FIG. 1.—*Various types of flexible metal gas tubing*

Samples Nos. 2, 3, 5, 6, and 9 depend for tightness primarily on a rubber thread packing within the metal spiral. Samples Nos. 55 and 57 are all metal, without packing. No. 3 is the most common type of tubing sold for general use. The rubber thread deteriorates with age and begins to leak. The greatest danger in this tubing is the poor connection with the end piece. (See Fig. 3.) No. 9 is a very superior grade of tubing adapted for general use and should give excellent service, and is cheaper in the long run than the inferior grades. Nos. 55 and 57 will stand higher temperatures and will be superior to the other types for many special purposes

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CONTENTS

	Page
I. Introduction	3
1. Purpose of investigation	3
2. Scope of tests and of this report	4
3. Cooperation with tubing manufacturers and gas associations	5
4. Enforcement	6
II. Tentative specifications of the National Commercial Gas Association and the American Gas Institute	7
III. Description of samples tested	9
IV. Experimental results	11
1. Transverse strength	11
2. Tensile strength	13
3. Pull required to remove end piece	15
4. Tightness when straight, bent, or twisted	17
5. Pressure loss	19
6. Flexibility	21
7. Heating test	22
8. Freezing tests	23
9. Rubber slip ends	23
10. Detachable metal end pieces	24
V. Discussion of results	26
VI. Modified specifications proposed	29
Appendix.—Gas-tubing inspection in Newark, N. J., by Ellsworth Francisco	33
1. Enforcement of ordinance	34
2. Permit to sell tubing	35
3. Regulations and tests	35
4. An ordinance prohibiting the sale and use of other than approved tubular connections for illuminating gas fixtures and appliances	37

I. INTRODUCTION

1. PURPOSE OF INVESTIGATION

A large number of accidents in recent years, resulting in loss of life and property, have been caused by the poor quality or the improper and careless use of flexible gas tubing. Some States and cities have prohibited the use of such tubing, and there has been increasing agitation, by fire-prevention authorities and others who are active in the cause of safety, for greater restrictions in the use of this material.

From the very beginning of its work on the Proposed National Gas Safety Code the Bureau of Standards has recognized the need for greater care in the selection and use of flexible tubing; but it has also believed that, by proper cooperation of all parties concerned, it should be possible to manufacture such a safe tubing and so to restrict its use to only proper purposes, that the hazards remaining would be practically only those caused by gross carelessness. For the full accomplishment of these objects the Bureau anticipates the need for:

1. A suitable specification for the construction of the tubing;
2. A prohibition against the use of poor tubing in any location and a restriction upon the use of even good grades were unnecessary, this to be accomplished by municipal or State regulation or fire-insurance rules; and
3. An educational campaign addressed to the general public, intended to gain the widest possible acceptance of and compliance with the rules above mentioned, even in places where they are not mandatory.

The importance of this subject has led to this investigation and the present report. The preliminary report of the tests was submitted to the manufacturers and gas company representatives nearly two years ago, but, due to numerous war activities, the work had to be discontinued for a while and is now presented with a little more experimental data and few changes in the specifications which the additional information and comments received from various interested parties, has shown to be necessary.

2. SCOPE OF TESTS AND OF THIS REPORT

This paper is intended only as a preliminary report of the more readily determined properties of about three dozen samples of tubing, some sent to us by the manufacturers and others bought from various retail stores. Many of the samples from the manufacturers were obtained through the courtesy of Oscar H. Fogg, formerly of the Consolidated Gas Co., New York City. We desire to express here our appreciation of Mr. Fogg's kind assistance in this work.

The preliminary investigation has shown that most of the samples are not worthy of further consideration and if more elaborate tests, such as life tests, are undertaken, they will be made only on those samples that showed up reasonably well in the preliminary work.

Our investigation has been limited largely to tests and examinations of the body of the tubing samples, but the strength of the joint between the tubing and the end pieces has also been studied to some extent.

The quality of the end piece is as important as that of the tubing itself, but no extended investigation was felt to be necessary, because a very few tests showed one sample to be so greatly superior to anything else that it should be adopted for all tubings equipped with rubber end pieces. This will be discussed more fully in the text.

3. COOPERATION WITH TUBING MANUFACTURERS AND GAS ASSOCIATIONS

The Bureau has received expressions of hearty cooperation from all the manufacturers with whom correspondence has been exchanged regarding tubing, and many have stated that they would be glad if some action could be taken to improve the standard of quality, but that there was a large demand for the very cheapest tubing and they were compelled to supply this demand. The attitude of the manufacturers is best shown by a few extracts from the numerous letters the Bureau has received:

No doubt all would agree with your purpose (elimination of dangerous tubing), but how to attain it is very difficult in our judgment. Basically the trouble is with the people. They demand junk and usually get it. If you have the power to standardize a rubber end, no one would be more pleased than we, provided it was not patented.

Inferior grades of compound and rubber are decidedly dangerous, and their use should be discouraged in every possible way. There are many types of very cheap tubing on the market that should never be used.

We are told by one of the largest manufacturing companies that the most regrettable phase of the whole situation is the lack of any recognized authoritative regulation or standard, and the apathetic attitude of the municipalities toward creating or enforcing ordinances prohibiting the sale and use of dangerous tubing. Furthermore, a manufacturing company may want to better its product, but the big business is in the cheap products, as there is a well-established line of stores that are concerned only in the sale and not in the quality of material which they are compelled to sell to the class to which they cater.

The demand is very largely for the cheapest tubing that can be turned out that will stay tight long enough for it to be sold.

The connection on the tubing is a matter of just as much importance as the tubing itself and good, satisfactory rubber ends can be obtained by anybody who is willing to pay the price. A majority of these tips, however, that are put out with cheap tubing are of such poor quality that they will harden or split, sometimes even before they are put into service. The ordinary method of attaching these rubber connections is to simply glue them onto the tubing, and while they would, of course, be safer if in addition to this they were held by a wire or clamp, there is not one customer in a hundred who will pay for this extra work.

The American gas engineers have realized that the interests of the gas industry require the production of a safe gas tubing, and as a result the National Commercial Gas Association and the American Gas Institute, working in conjunction, formulated a set of tentative specifications and presented them at the 1916 meeting of these societies. The tests reported in this paper have been made along the lines suggested by these proposals and the results will be discussed to show where, in our judgment, these tentative specifications are too rigid, where too lenient, and to what extent these specifications fulfill their purpose, i. e., of providing safe, convenient, and commercially suitable tubing.

Before final adoption of specifications, either by the gas associations or the Bureau of Standards for the National Gas Safety Code, it is anticipated that cooperation in this work will enable the Bureau and the associations to formulate mutually satisfactory standards so that the specifications which are finally adopted may be identical. As a step toward this highly desirable end, this report of tests has been prepared and is now presented to bring out the further discussion which is essential before more definite recommendations should be made.

4. ENFORCEMENT

Some doubt has been expressed as to the value of any specifications, because there is no authority for the enforcement of such specifications except as they may be adopted by municipal authorities in restricting the sale of the dangerous tubing. Much may be done even by this means, as is shown by the work of Mr. Francisco, in Newark, N. J., described in a later section of this report.

The gas companies also can do a great deal by restricting the tubing that they sell to only the better grades and by showing the people that it is really an economy to buy the better qualities.

The fire department and insurance rules are, in general, becoming more strict, and for many localities restrictive measures on the use of flexible tubing have been under consideration for some time. In fact there is a possibility, unless the parties who see a legitimate use for the flexible tubing succeed in getting the dangerous types off the market, that the above-mentioned organizations will take some action to prohibit entirely the use of all tubing.

A certain amount of publicity in which there could be brought out the economy of good tubing, as well as the additional safety,

would appeal to a great many people and would make easier the enforcement of ordinances regarding tubing.

The gas associations are also going to take some action just as soon as satisfactory specifications are agreed upon, and their membership will undoubtedly favor those manufacturers who are willing to cooperate and work for the real interests of the gas business. This we expect to be one of the greatest immediate forces which will restrict the manufacture of these dangerous tubings.

II. TENTATIVE SPECIFICATIONS OF THE NATIONAL COMMERCIAL GAS ASSOCIATION AND THE AMERICAN GAS INSTITUTE AS PRESENTED AT THE 1916 MEETINGS OF THESE SOCIETIES

Many of the larger gas companies have made tests of tubing in their appliance laboratories and are confining the sales through their commercial departments to the best qualities that they can find. The tentative specifications of the National Commercial Gas Association and the American Gas Institute, above referred to, have been formulated by those men who have been in touch with much of this experimental work, and the requirements contained in these specifications cover in the main the weaknesses brought out by their tests. The committee of the National Commercial Gas Association in reporting its recommendations refer to them as follows:

A standard specification of flexible tubing, describing the composition and construction in detail, is demanded by the industry. Increasing agitation in the cause of safety, the imposition of ever stricter requirements by fire prevention authorities, and a proper regard for the essential interests of the industry, call for the production of a flexible tubing that shall be substantially as safe as a rigid metal pipe. We need a tubing in which it is safe to allow the gas pressure to remain at all times.

To meet the requirements, the tubing must (*a*) be sufficiently flexible to hang in a graceful, natural curve; (*b*) maintain its flexibility unchanged throughout its life; (*c*) be noncrushable under the heel of a person of ordinary weight; (*d*) be nonbreakable and gas-tight when subjected to extreme bending; (*e*) be noncombustible, in the sense that if all the outer coverings are burned off the metal base of the tubing will still retain its form, and the leaking gas will be so small in volume that the flame at 3-inch pressure will not be over 1½ inches long; (*f*) if caused to leak by mechanical injury or by fire, develop only small, nondangerous leaks, so long as the tubing maintains its form; (*g*) not absorb the moisture from the atmosphere; (*h*) if uninjured, remain gas-tight indefinitely; and (*i*) permit of the attachment of metal ends in such a way that they can not be pulled off.

The tentative specifications given in Exhibit "*b*," we believe describes a tubing that will meet these requirements. The spiral metal base gives the required strength, flexibility, noncollapsibility, noncombustibility, and security of attachment for the metal ends; the composition coating lends the desired gas-tightness, and uniformity

in elasticity and plasticity; the two wrappings of oiled paper protect the elastic coating from mechanical abrasion and from the moisture of the atmosphere; and the woven outer coverings contribute the good looks.

This specification is submitted for consideration and criticism, with the thought that at the 1917 meeting it will be ripe for adoption as a standard.

The tentative specifications, in so far as they relate to the tubing itself, were presented to these societies as committee reports in the following form:

Transverse Strength.—Tubing to be capable of withstanding, without crushing, a load of 100 pounds per running inch.

Tensile Strength.—Tubing to be capable of withstanding, without rupture, a steady load of 75 pounds.

Torsional Strength.—Tubing, when subjected to a twisting movement, acting either clockwise or counterclockwise, to be capable of withstanding, without rupturing, an angular deflection of 180° per lineal foot.

Dimensions.—The inside diameter of tubing (diameter of gas way) to be either $\frac{3}{16}$, $\frac{5}{16}$, $\frac{3}{8}$ inch, or other size as need may develop. The outside diameter to be no larger than necessary to comply with the requirements of this specification. Maximum outside over-all diameter to be $\frac{7}{16}$ inch for the $\frac{3}{16}$-inch tubing, $\frac{9}{16}$ inch for the $\frac{5}{16}$-inch tubing, and $\frac{5}{8}$ inch for the $\frac{3}{8}$-inch tubing. Variation of $\frac{1}{32}$ inch from these dimensions allowable.

Flexibility.—A 1-foot length of either $\frac{3}{16}$, $\frac{5}{16}$, or $\frac{3}{8}$ inch tubing when held horizontally at one end, should have a drop of at least 45°, this angle being measured between the horizontal axis of the point of support and a line connecting the point of support with the free end of the tubing.

Bending.—Either $\frac{3}{16}$ or $\frac{5}{16}$ inch tubing to be capable of withstanding, without rupture, the strain produced by bending the tubing into a circle of 2 inches mean diameter. Three-eighths-inch tubing to be capable of withstanding without rupture, a strain produced by bending the tubing into a circle of 3 inches mean diameter.

Pressure loss.—A 6-foot length of $\frac{3}{16}$-inch tubing, equipped with the specified rubber slip ends, or with the specified metal ends, secured in the specified manner, shall not show a pressure loss in excess of $\frac{4}{10}$ inch of water, when passing gas of 0.6 specific gravity at the rate of 5 cubic feet per hour.

Similarly, a 6-foot length of $\frac{5}{16}$-inch tubing shall not show a pressure loss in excess of $1\frac{1}{10}$ inches of water, when passing gas at the rate of 30 cubic feet per hour.

Similarly, a 6-foot length of $\frac{3}{8}$-inch tubing shall not show a pressure loss in excess of $\frac{3}{10}$ inch of water, passing gas at the rate of 30 cubic feet per hour.

Tightness.—A 6-foot length of the tubing, when connected up to the outlet of a gas meter graduated to read to $\frac{1}{100}$ of a cubic foot, and subjected to a gas pressure of at least 6 inches of water, shall show no leakage over a 15-minute period.

Construction.—Tubing to consist of the following component parts, which are given in their order from the inside to the outside of the tubing: (*a*) Rubber-packed metallic core; (*b*) waxed-paper wrapping; (*c*) braided cotton-fabric sheath impregnated and coated on one side only with a gas-proof and gas-tight compound; (*d*) waxed-paper wrapping; (*e*) braided cotton covering; and (*f*) silk, silkaline, or cotton-finish covering.

(*a*) Metallic core to be formed of one unbroken strip of metal, wound spirally, with an interlocking seam, made gas-tight by a continuous rubber threadlike gasket.

(*b*) and (*d*) Waxed paper to be of such a grade and width and so wound that it will form a covering impervious to moisture when the tubing is subjected to specified bending tests.

(*c*) Woven cotton fabric to be of such a character as to absorb and securely hold the specified quantity of the compound; the compound to be of such composition that it will not soften to a sufficient extent to ooze through the waxed-paper wrapping when

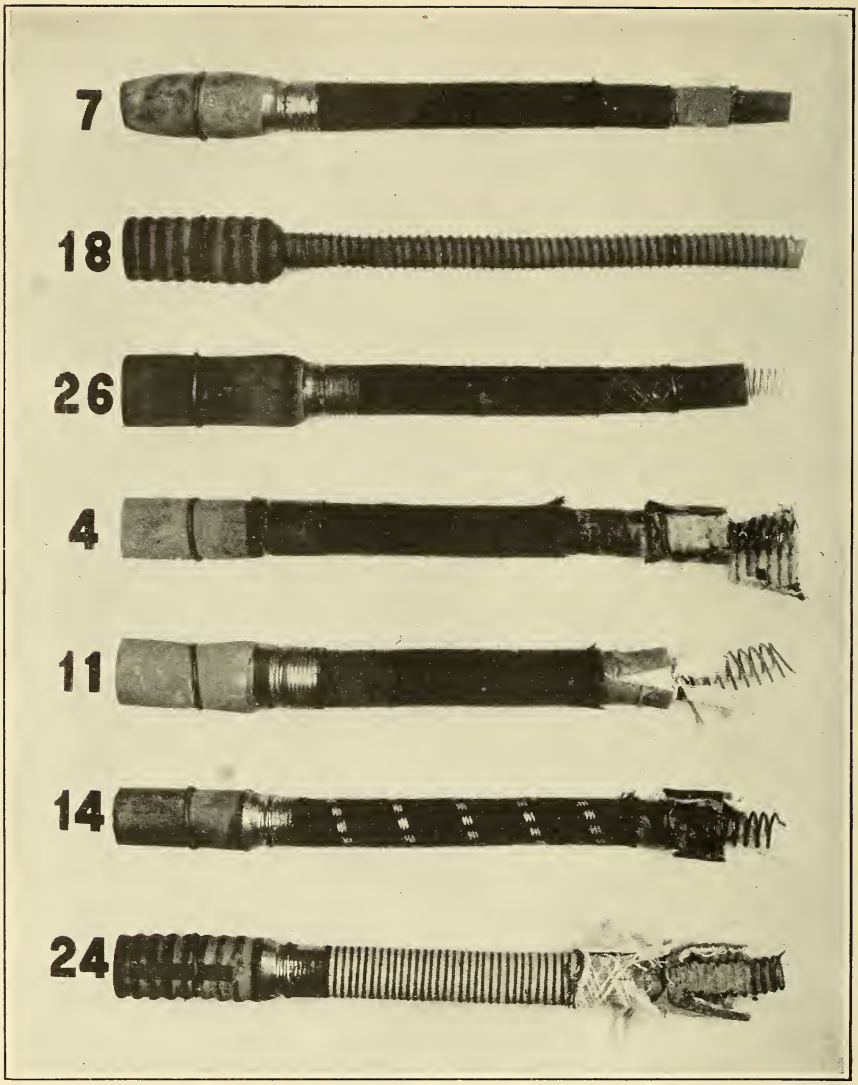


FIG. 2.—*Various types of rubber and paper gas tubing*

Samples Nos. 7 and 18 are of rubber and fabric construction and are the best of this type. If used with care, they will probably last as long as the metal tubings, but there is a slightly greater fire hazard from their use if they are subjected to heat. Nos. 4, 11, and 14 are dangerous types of tubings constructed of paper, covered with various composition mixtures, on a wire spiral, the whole covered with a cotton braiding, giving it a good outside appearance. The glue soon hardens and cracks upon bending the tubing. One manufacturer of tubing says of such material, "The demand is very largely for the cheapest tubing that can be turned out that will stay tight long enough for it to be sold"

the tubing is subjected for a period of 48 hours to an atmosphere at 100° F and 100 per cent humidity; and that, when subjected for 48 hours to an atmosphere of 0° F, it shall not crack or lose its gas-tight property when subjected to the test for bending. A sufficient quantity of the compound to be used to insure a thickness of the impregnated and coated cotton fabric of not less than $\frac{1}{32}$ inch or more than $\frac{3}{64}$ inch.

(*e*) Cotton covering, if dyed, to be dyed with *fast* color, preferably to match color of finish covering or of some neutral tint, and of such a texture as proper to protect the paper from abrasion.

(*f*) Finish covering to be furnished as ordered. To be dyed with *fast* color.

III. DESCRIPTION OF SAMPLES TESTED

The following is a brief description of the various samples tested in our work and for which results of tests will be shown. For sake of convenience the samples are divided into three classes.

Class I. Tubings which are built around a gas-tight metallic core.

Class II. Tubings without metal core and containing at least some rubber in their composition.

Class III. Tubings without meta. core or rubber layer and depending for tightness chiefly on paper or cotton, covered or impregnated with a composition of glue and glycerin or some other preparation.

Some of these various types of tubings and end pieces are shown in Figs. 1, 2, and 3.

CLASS I TUBINGS

Sample No. 1: Construction—1, rubber-packed metal core; 2, cotton fabric; 3, composition; 4, paper; 5, braided cotton covering. Dimensions—Inside, $\frac{3}{16}$ inch; outside, 3/8 inch. End piece—Rubber, internally corrugated, cemented to metal tailpiece inserted into tubing.

Sample No. 2: Construction—1, rubber-packed metal core; 2, cotton fabric; 3, composition; 4, paper; 5, braided cotton covering; 6, braided outer cotton coverings. Dimensions—Inside $\frac{3}{16}$ inch; outside, $\frac{7}{16}$ inch. End piece—Metal threaded end screwed into core, forming the tailpiece.

Sample No. 3: Construction—1, rubber-packed metal tubing; no covering. Dimensions—Inside, $\frac{3}{16}$ inch; outside, 1/4 inch. End piece—Barrel-shaped rubber, ends cemented on tube.

Sample No. 5: Construction—1, rubber-packed metal core; 2, thin cotton fabric; 3, paper; 4, loose-woven cotton fabric impregnated with composition; 5, paper; 6, braided cotton covering. Dimensions—Inside, $\frac{5}{16}$ inch; outside, $\frac{9}{16}$ inch. End piece—Rubber, cemented to wooden plug inserted into tubing.

Sample No. 6: Construction—1, rubber-packed metal tubing; 2, braided cotton covering. Dimensions—Inside, $\frac{3}{16}$ inch; outside, $\frac{5}{16}$ inch. End piece—Rubber, cemented on tube.

Sample No. 9: Construction—1, rubber-packed metal core; 2, paper; 3, cotton-fabric composition; 4, paper; 5, braided cotton covering; 6, braided outer cotton covering. Dimensions—Inside, $\frac{3}{16}$ inch; outside, 1/2 inch. End piece—Rubber, internally corrugated, cemented to metal tailpiece inserted into tubing.

Sample No. 17: Construction—1, rubber-packed metal core; 2, paper; 3, cotton fabric; 4, composition; 5, paper; 6, braided cotton covering; 7, braided cotton covering; 8, braided outer silk covering. Dimensions—Inside, $\frac{3}{16}$ inch; outside, 1/2 inch. End piece—Metal, threaded end screwed into core, forming the tailpiece.

Sample No. 21: Construction—1, rubber-packed metal core; 2, paper; 3, cotton fabric; 4, composition; 5, paper; 6, braided cotton covering; 7, braided outer cotton covering. Dimensions—Inside, $\frac{3}{16}$ inch; outside, $\frac{7}{16}$ inch. End piece—Metal, threaded end screwed into core, forming the tailpiece.

Sample No. 25: Construction—1, rubber-packed metal core; 2, paper; 3, cotton fabric; 4, composition; 5, braided cotton; 6, braided outer cotton. Dimensions—Inside, ¼ inch; outer side, $\frac{9}{16}$ inch. End piece—Threaded metal, end screwed into metal core, forming the tailpiece.

Sample No. 29: Construction—1, rubber-packed metal tubing; no covering. Dimensions—Inside, ¼ inch; outside, ⅜ inch. End piece—Barrel-shaped rubber, ends cemented on tube.

Sample No. 49: Construction—1, flexible brass tubing, gas-tight without packing; no covering. Dimensions—Inside, ¼ inch; outside, $\frac{6}{16}$ inch. End piece—Threaded brass end soldered to tubing.

Sample No. 50: Construction—1, flexible brass tubing, gas-tight without packing; 2, braided metal covering. Dimensions—Inside, ¼ inch; outside, ½ inch. End piece—Threaded brass end soldered to tubing.

Sample No. 51: Construction—1, flexible brass tubing, gas-tight without packing; no covering. Dimensions—Inside, ¼ inch; outside, $\frac{6}{16}$ inch. End piece—Rubber, end cemented to tubing.

Sample No. 52: Construction—1, flexible-brass tubing, gas-tight without packing, no covering. Dimensions—Inside, $\frac{5}{16}$ inch; outside $\frac{7}{16}$ inch. End piece—Threaded brass end, soldered to tubing.

Sample No. 53: Construction—1, flexible-brass tubing, gas-tight without packing. Dimensions—Inside, $\frac{5}{32}$ inch; outside, $\frac{7}{32}$ inch. End piece—Threaded brass end soldered to tubing.

Sample No. 54: Construction—1, flexible-steel tubing, gas-tight without packing, braided metal covering. Dimensions—Inside, ¼ inch; outside, $\frac{7}{16}$ inch. End piece—Threaded brass ends soldered to tubing.

Sample No. 55: Construction—1, flexible-steel tubing, gas-tight without packing, no covering. Dimensions—Inside, $\frac{5}{16}$ inch; outside, ½ inch. End piece—Threaded brass ends, soldered to tubing.

Sample No. 56: Construction—1, flexible-steel tubing, gas-tight without packing, no covering. Dimensions—Inside, ¼ inch; outside, ⅜ inch. End piece—Rubber ends, cemented to tubing.

Sample No. 57: Construction—1, Spring-steel wire spiral with metal ribbon wound around the outside and into the coils of inner spiral.

Sample No. 58: End piece only. Detachable metal variety, made for any kind of tubing.

CLASS II TUBING

Sample No. 7: Construction—1, black-rubber core; 2, two layers of impregnated fabric; 3, red-rubber layer; 4, composition; 5, braided cotton covering. Dimensions—Inside, ¼ inch; outside, $\frac{9}{16}$ inch. End piece—Rubber, cemented to threaded metal tailpiece.

Sample No. 8: Construction—1, rubber tube; 2, composition. Dimensions—Inside, $\frac{5}{16}$ inch; outside, ⅝ inch. End piece—No end.

Sample No. 10: Construction—1, wire helix; 2, rubber tube; 3, composition, wrapped with thread; 4, braided cotton cover. Dimensions—Inside, $\frac{5}{16}$ inch; outside, $\frac{9}{16}$ inch. End piece—Barrel-shaped rubber ends, cemented to metal tailpiece.

Sample No. 16: Construction—1, rubber tube; 2, composition; 3, paper; 4, braided cotton covering. Dimensions—Inside, ¼ inch; outside, $\frac{9}{16}$ inch. End piece—Barrel-shaped rubber, cemented to wooden plug inserted into tubing.

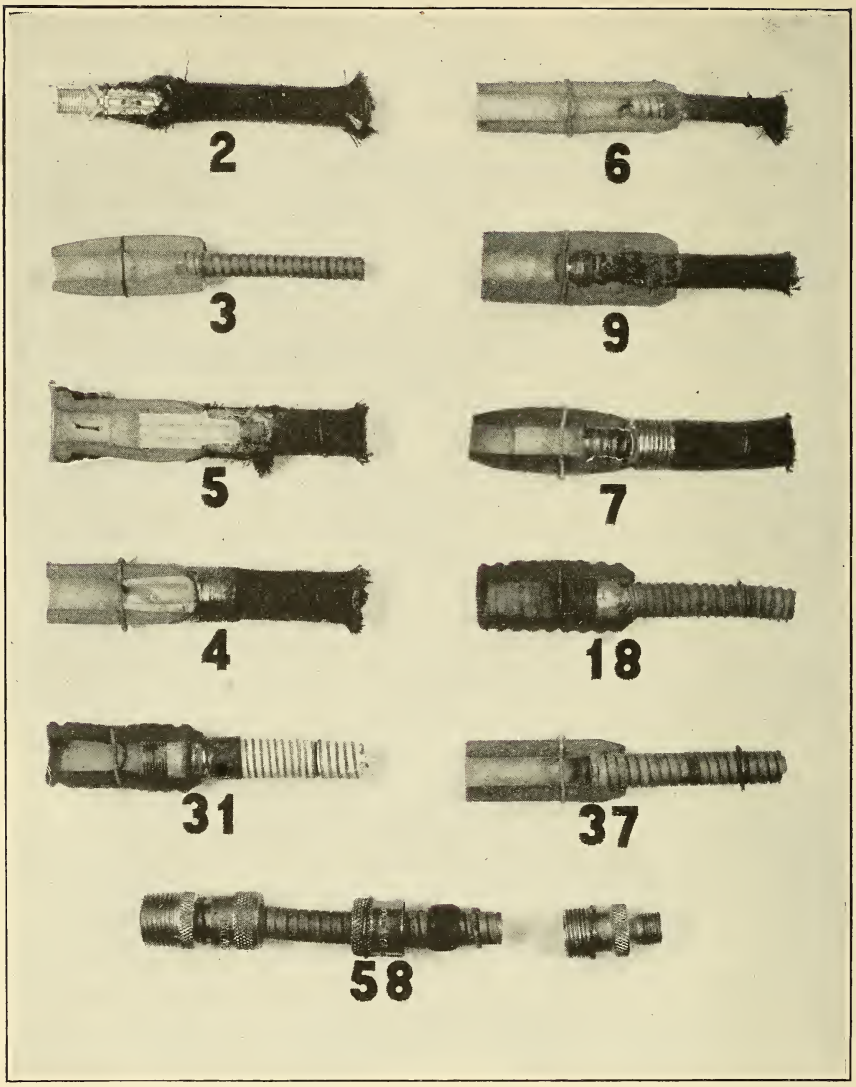


FIG. 3.—*Various types of tubing ends*

The cause of frequent leaks around the end pieces is readily understood by a study of samples Nos. 3, 6, and 37. In these the tubing is inserted but a short distance into the end piece and is glued in place. With a little handling they become loosened and the end piece may drop off any time. No. 5 is a common but not always satisfactory connection, consisting of a wood tailpiece glued into the tubing and rubber end. The gas passage is unduly restricted. Compare these samples with No. 9, in which a metal tailpiece is screwed into end of tube and is held in rubber end piece by corrugations which fit corresponding corrugations in the rubber. The modified specifications require something equivalent to this quality and construction

Sample No. 18: Construction—1, rubber tube; 2, three layers of impregnated cloth; 3, layer of red rubber; 4, wire wrapping. Dimensions—Inside, $\frac{3}{16}$ inch; outside, $\frac{7}{16}$ inch. End piece—Rubber, with inner and outer corrugations, cemented to metal tailpiece inserted into tubing.

Sample No. 22: Construction—1, rubber tube; 2, composition; 3, braided cotton covering. Dimensions—Inside, $\frac{3}{16}$ inch; outside, ⅜ inch. End piece—Threaded metal end inserted into tubing forming tailpiece.

Sample No. 23: Construction—1, wire helix; 2, rubber tube; 3, composition, wrapped with thread; 4, braided cotton covering. Dimensions—Inside, ¼ inch; outside, ½ inch. End piece—Threaded metal end inserted into tubing forming tailpiece.

Sample No. 26: Construction—1, wire helix; 2, rubber tube; 3, composition, wrapped with thread; 4, braided cotton covering. Dimensions—Inside, $\frac{5}{16}$ inch; outside, ⅝ inch. End piece—Rubber attached to corrugated metal tube inserted in tubing.

Sample No. 28: Construction—1, black-rubber tube; 2, thin composition; 3, braided cotton covering. Dimensions—Inside, $\frac{3}{16}$ inch; outside, ⅜ inch. End piece—Brass threaded end inserted into tubing, forming tailpiece.

Sample No. 34: Construction—1, thick rubber tubing; 2, composition; 3, paper; 4, braided cotton covering. Dimensions—Inside, ¼ inch; outside, ½ inch. End piece—Barrel-shaped rubber, cemented to wooden plug, inserted into tube.

CLASS III TUBINGS

Sample No. 4: Construction—1, wire helix; 2, cloth; 3, paper impregnated with composition; 4, paper; 5, braided cotton covering. Dimensions—Inside, $\frac{5}{16}$ inch; outside, ⅝ inch. End piece—Rubber cemented to wood plug, inserted into tubing.

Sample No. 11: Construction—1, wire helix; 2, cloth; 3, paper; 4, composition; 5, paper; 6, braided cotton covering. Dimensions—Inside, ⅜ inch; outside $\frac{11}{16}$ inch. End piece—Rubber cemented to wood plug, inserted into tubing.

Sample No. 14: Construction—1, wire helix; 2, paper; 3, threads laid lengthwise; 4, paper impregnated with composition; 5, braided cotton covering. Dimensions—inside, $\frac{5}{16}$ inch; outside, $\frac{9}{16}$ inch. End piece—Rubber end cemented to wood plug, inserted into tube.

Sample No. 24: Construction—1, wire helix; 2, paper; 3, threads laid lengthwise; 4, composition; 5, paper; 6, cotton-thread wrapping; 7, paper; 8, cotton-thread wrapping; 9, asbestos covering; 10, wire wrapping. Dimensions—Inside, $\frac{5}{16}$ inch; outside, ⅝ inch. End piece—Rubber externally corrugated, attached to corrugated metal tube, inserted into tubing.

Sample No. 31: Construction—1, wire helix; 2, paper; 3, threads laid lengthwise; 4, composition; 5, paper; 6, cotton-thread wrapping; 7, asbestos covering; 8, wire wrapping. Dimensions—Inside, $\frac{3}{16}$ inch; outside, $\frac{7}{16}$ inch. End piece—Rubber externally corrugated, attached to metal tube inserted in tubing.

Sample No. 33: Construction—1, wire helix; 2, paper; 3, threads laid lengthwise; 4, composition; 5, thin sheet of asbestos paper; 6, cotton-thread wrapping; 7, braided cotton covering. Dimensions—Inside, ¼ inch; outside, ½ inch. End piece—Rubber, connected to tubing with metal tube.

IV. EXPERIMENTAL RESULTS

1. TRANSVERSE STRENGTH

For determining the transverse strength—that is, the resistance to crushing—the tubing was placed in a Tinius Olsen universal testing machine, and the load at which the tubing was flattened out sufficiently to shut off the gas was noted. The data from our tests are shown in Table 1. The following observations and con-

clusions are drawn as to the relation between transverse strength and the character of the tubing:

TABLE 1.—Resistance of Tubing to Crushing

Class I samples				Class II samples		Class III samples	
With rubber packing		Without rubber packing					
Sample No.	Crushing load (pounds per linear inch)	Sample No.	Crushing load (pounds per linear inch)	Sample No.	Crushing load (pounds per linear inch)	Sample No.	Crushing load (pounds per linear inch)
1	525	49	500	7	150	4	135 100
2	700	50	700	8	10 10	11	130 65
3	400	51	500	10	200	14	130
5	300	52	450	16	25 17	24	180
6	700	53	435	18	150	31	370
9	600	54	800	22	20	33	190
17	700	55	770	23	180	.....	.....
21	750	56	685	26	200	.....	.....
25	400	57	.....	28	30	.....	.....
29	280	.....	.....	34	25	.....	.....

It was our interpretation of the committees' proposal that "tubing to be capable of withstanding without crushing" meant without crushing sufficiently to cause either leakage or shutting off of the gas. We believe this should be clear in the specification and have so modified the wording. However, it is not intended that our tests should be used as a guide to the strength of tubing in respect to its resistance to rupture under transverse load, since they apply only to the matter of actual crushing to shut off the passage of gas.

1. In most tubings the transverse strength depends primarily upon a metallic core or an interior or exterior wire helix; sample No. 7 was the only one without such construction that came up to the proposed requirement of resistance to 100 pounds per linear inch. This tube was one built much like a garden hose.

2. The transverse strength of samples in Class I (with metal core) is much greater than that of the other types, being usually above 300 pounds per linear inch; but some samples in Classes II and III are also considerably above the proposed specifications of 100 pounds. The only tube equalling those with metal core was No. 31, which is of small diameter and has two wire helixes.

3. If a metal core is required it can readily be made of sufficient strength to prevent serious crushing of the core or a momentary

interruption of the gas supply, even if the tube is accidentally stepped on while in use.

4. If otherwise satisfactory, a tubing which depends upon a good wire helix for transverse strength can be made sufficiently resistant against crushing to be regarded as safe in this particular, since a strength of 100 to 200 pounds is secured by this method of construction.

5. Samples Nos. 8, 16, 22, 28, and 34 which had no metal core or wire helix were very easily flattened out at 10 to 30 pounds per linear inch. This shows the limitations of such construction, and that without such wire or metal base a tubing should not be regarded as generally applicable, though it would perhaps be safe in certain special work.

6. The larger diameter tubing, whether wire helix or metal core, is generally more easily crushed than that of small diameter, as is evident by comparison of No. 24 with 31, 25 with 21, 29 with 3, and 5 with 2, of which pairs the first named differs from the second principally by being larger in diameter.

7. It might appear from comparison of Nos. 3 and 29 with 2 and 25, respectively, that the bare metal tubing was less resistant to crushing than those covered with composition and fabric. However, this seems improbable, for No. 7 is as strong as Nos. 2 and 17, and one could scarcely credit to the single layer of cotton fabric any great strength. Therefore, it seems that Nos. 3 and 29 are weaker because of somewhat inferior metal and our conclusion numbered (1) above seems justified.

From these observations it is evident that the proposed requirement of transverse strength is extremely easy of compliance for any metal-core or wire-helix tubing; but in our opinion it is not necessary to make it more severe, since 100 pounds per linear inch is the maximum load to be expected. In other words, we assume that the severity of treatment anticipated, and not the commercially possible strength, should determine the specification, in order that some less expensive form of construction that really would be adequate and safe may not be excluded from future consideration.

2. TENSILE STRENGTH

The tensile strength was determined in the same machine in which the transverse tests were made. The tests consisted in taking a firm grip on each end of a piece of tubing about 12 inches long and noting the maximum load before break.

Undoubtedly some leakage would occur through some of these tubings before such maximum load was reached, but the methods used in these preliminary tests did not permit determination of this point. However, the margin of safety above the proposed requirement is so great with the steel-core tubing, in which class such leakage would be most probable, that we feel no hesitation in tentatively accepting the test of breaking strength as a guide.

The results of the tests of tensile strength which we have made are given in Table 2; the following conclusions are drawn:

1. Samples of Class I with rubber-packed steel core pass the proposed specifications, with a wide margin of safety in every case except sample No. 3. The majority of samples in this class are representative of good steel-core tubing which has a tensile strength of 175 to 250 pounds.

2. Of the steel-core, rubber-packed, tubings, No. 9 is unquestionably of the best construction. Sample No. 3 is by far the weakest of this group, partly as a result of small diameter, partly because of apparently inferior material and design, and partly because it has no fabric or composition to contribute to its strength.

3. Of the Class I tubings without packing, a number fall below the specifications in tensile strength, but if covered with metal braiding, as Nos. 50 and 54, they can be made strong enough.

4. Of the rubber tubings, Nos. 7 and 18 each contains two layers of rubber, apparently of fine quality, and represents the best form of tubing without steel core which we have examined.

5. Of the medium to fair grades of rubber tubings (samples Nos. 10, 16, 22, 23, 26, 28, and 34) the strength was largely dependent upon the thickness and quality of the rubber; but in one instance (No. 23) the use of a heavily threaded composition contributed largely to the strength.

6. One of the most dangerous styles of rubber tubing on the market is illustrated by sample No. 8. This general class of tubing is not worthy of any consideration in the drafting of a specification.

7. Of Class III, no more consideration should be given to materials like Nos. 4 and 14 than is credited to those like No. 8. This style is largely sold by 5 and 10 cent stores and similar establishments. Sample No. 11 is scarcely any better. It does have the advantage of a strong composition and fabric layer, which produces a tensile strength above the proposed requirement; however, it would fail to pass in other particulars.

8. The tensile strength of samples Nos. 24, 31, and 33 illustrates the possibility of full compliance with this specification by use of a strong composition containing lengthwise threads.

TABLE 2.—Tensile Strength of Tubing

Class I samples				Class II samples		Class III samples	
With rubber packing		Without rubber packing					
Sample No.	Tensile strength	Sample No.	Tensile strength	Sample No.	Tensile strength	Sample No.	Tensile strength
	Pounds		Pounds		Pounds		Pounds
1	180 280	49	70 60	7	104 100	4	60, 78, 70 53, 62, 58
2	238 200	50	1370	8	48 48	11	100 105
3	78 90	51	80	10	68 70	14	40, 58 49, 55, 50
5	248 240	62	60 80	16	110 100	24	190 218
6	172 180	53	70	18	108 120	31	215 210
9	350 350	54	380	22	82 62, 80	33	195 180
17	220 220	55	80	23	100	.....	.....
21	175 200	56	90	26	72 74	.....	.....
25	240 248	57	.....	28	68 66, 82	.....	.....
29	136 130	.....	.....	34	[a] 130 70, 62	.....	.....

[a] Probably incorrect value.

Tubing is often accidentally subjected to pulls and strains of uncertain magnitude, but the 75-pound requirement seems adequate to protect the tubing against such strain; since all of the samples that are otherwise acceptable had a tensile strength considerably in excess of that figure, there will be no difficulty in meeting such requirement. Here again, however, we believe the wording should be more explicit, so that it will be evident that the tubing must not leak after being subjected to a 75-pound pull. We therefore suggest a slightly modified form for the specification.

3. PULL REQUIRED TO REMOVE END PIECE

No complete specifications have yet been proposed by the gas association committees for attaching the rubber ends to the flexible tubing, but it was evident from the number of leaks

found around the end connections and the small pull required to remove some of them that this was one of the weak spots in many tubings.

Our tests of the strength of the joint were made by the same general method as was used in the tests of tensile strength. The results are presented in Table 3, and the following general conclusions are drawn:

1. In the rubber-packed, metal-core tubings the metal tailpiece which was screwed into the corrugations of the metal core seemed to be as tight and as strong as the other part of the tubing.

2. When a rubber end was fastened over such a metal tailpiece the connection between tailpiece and tubing was stronger, in every case but one, than that between the tailpiece and the rubber. When the corrugations of the tailpiece were fine the grip of the rubber was good, requiring a pull of 100 to 170 pounds to separate it (see especially samples Nos. 1, 9, 7, and 18; also Nos. 31 and 33, which were very similar), but with coarse corrugations on the metal tailpieces, e. g., samples Nos. 10 and 26, the rubber seems to pull off much more readily at 50 to 80 pounds.

3. When metal end pieces were attached by making the tail piece a part of the metal end itself, the strongest construction was obtained, as shown by samples Nos. 2, 17, 21, 25, 22, and 28, all of which pulled off at 100 to 250 pounds or resisted sufficient pull to break the tubing itself (in each case more than 100 pounds).

4. When a rubber end was attached to a wood plug, as in Nos. 16, 34, 4, 11, and 14 the break occurred at 50 to 80 pounds, either in the tubing or by separation of all or part of the rubber end piece, according to the relative strength of the parts. One exception to this group was sample No. 5, which was unusually strong and well made.

5. When the rubber end was attached to bare metal, as Nos. 3, 29, and 51, or to metal covered with a single fabric layer, the strength of the joint was small and separation of the end occurred with a pull of 30 to 80 pounds. Moreover, this style of joint is much weakened by the strains which occur while the tube is being attached to or detached from piping or appliances.

6. In the case of brass and steel tubings without rubber packing to which metal ends were brazed or soldered, the joint was invariably stronger than the tubing itself.

As a general conclusion, we believe the joint between tube and end piece could properly be required to be of such strength as to

easily resist a pull of at least 75 pounds, which is the strength recommended for the tubing itself.

TABLE 3.—Pull to Remove End Piece

Class I samples				Class II samples		Class III samples	
With rubber packing		Without rubber packing					
Sample No.	Pull	Sample No.	Pull	Sample No.	Pull	Sample No.	Pull
	Pounds		Pounds		Pounds		Pounds
1	110 150	49	(a)	7	100	4	(a)
2	130 90	50	(a)	8	No end	11	74 80
3	64 65	51	46 (a)	10	60 80	14	(a)
5	160 118	52	(a)	16	72 46	24	No test
6	80 80	53	(a)	18	106 110	31	118
9	125 160	54	(a)	22	(a)	33	168
17	148	55	(a)	23	No test	.....	.....
21	146	56	52	26	50	.....	.....
25	250	57	.....	28	(a)	.....	.....
29	35	.....	.....	34	(a)	.....	.....

a Tubing broke before end pulled off.

4. TIGHTNESS WHEN STRAIGHT, BENT, OR TWISTED

The tightness of various tubing samples was determined by attaching one end of the tubing to the outlet of a wet gas meter ($\frac{1}{10}$ cubic foot per revolution) and stoppering the other end. Gas was turned on through the meter and maintained in the tubing at a pressure of 6 inches of water. After the gas had stood in the tubing for about 20 minutes the leakage was determined over intervals of 5 minutes.

In order to make sure that no leakage occurred at the connections to the meter or at the stoppered end these points were tested with soapy water. The figures reported as leakage, therefore, represent the actual seepage through the tubing or through such small leaks around the end pieces as were too small to locate with the soapy water.

To determine whether the tubing would develop any additional leakage when bent into a circle of about 3 inches in diameter each sample was coiled about a form of that size and another

leakage test made. This observation was then repeated 20 minutes later with the tubing still coiled about the form. Again after straightening the tubing the 5-minute observation was made and still another test 20 minutes after straightening. It was thought that these tests at intervals would reveal any fatigue of the rubber packing or the composition layers of the tubing that might occur during short periods after bending or the recovery occurring within a short time after the straightening of the tube.

Similar leakage tests were made on the tubing after twisting a 1-foot length of it through 180° both clockwise and counterclockwise. The results of these observations are given in the following table only in a summarized form since practically no significant differences in leakage were noted under the different conditions. The two values given for each sample, therefore, represent the minimum and the maximum value for that material and do not bear any special relation to the question of bending or twisting.

TABLE 4.—Tightness of Tubing

Class I samples				Class II samples		Class III samples	
With rubber packing		Without rubber packing					
Sample No.	Leakage (thousandths cubic foot per hour per 6-foot length)	Sample No.	Leakage (thousandths cubic foot per hour per 6-foot length)	Sample No.	Leakage (thousandths cubic foot per hour per 6-foot length)	Sample No.	Leakage (thousandths cubic foot per hour per 6-foot length)
1	5–9	49	0	7	3	4	1–9
2	0	50	0	8	3–7	11	0–2
3	2–6	51	0	10	2–6	14	(a)
5	24–48	52	0	16	0–2	24	(b)
6	10–30	53	0	18	0	31	2
9	3–6	54	0	22	0	33	14–18
17	0	55	0	23	(b)	.....	.....
21	2–7	56	(b)	26	(a)	.....	.....
25	0–3	57	0	.....	.....	.....	.....
29	(a)	.....	.....	28	0	.....	.....

a Leak in connection. b No test.

There are tubings on the market which have some very desirable properties, but can not be twisted very much without leaking. It seems that such tubing might be entirely satisfactory if it were so strong that it required more force to twist it than would be applied to it in ordinary use. Attaching a hose over a nozzle is usually accomplished with a twisting motion, especially if the nozzle is too large for the end piece. It was found by a few rough

tests that the force one might apply in such a case was about equal to a weight of 2 pounds at the end of a lever 12 inches long. And this minimum requirement is incorporated into the specifications.

As will be seen from the table, the leakage was very small; but very few samples would comply with the committee's proposed requirement of showing absolutely no leakage. Most of the detected leaks were near the end connections and a large number of such leaks were found on samples which were therefore discarded from further tests. Practically all of the tubings were so nearly tight as to make it impossible to judge anything as to the relation between tightness and make-up of the tube. However, we believe that a longer series involving life tests will develop the necessary information as to the tightness of the tubing after use under various conditions. Such further work is contemplated.

It is evident that the leakage is of such small magnitude in practically every case as to introduce no element of hazard under ordinary conditions of use unless large deterioration resulted with time. We believe, therefore, that the specifications should allow such small leakage as has been found in the better-grade samples which we have tested. Indeed, we think this would be essential if precise compliance with the proposed specifications were expected. It appears to us that it would be entirely proper to permit tubings that would not show leakage in excess of 0.02 cubic foot per hour per 6-foot length, though it may be entirely feasible to specify a limit of 0.01 cubic foot per hour.

5. PRESSURE LOSS

Pressure loss on the different samples was determined by having a pressure gauge at each end of a 6-foot section of a gas tube, including end pieces, and noting the loss in pressure when passing gas at either 5 or 30 cubic feet per hour. The pressure loss in most samples was not excessive. In the few cases, for which it was large, it was caused by a constriction in each end which resulted from the method by which the end piece was attached The results of our tests are presented in Table 5.

If the interior diameter of the tubing is specified, the only object in specifying the pressure loss is to prevent any such undue constrictions so that the tubing will deliver a certain quantity of gas at a minimum loss in pressure. After the methods for attachment of ends are fully developed, it will not be necessary to retain any specification for pressure loss since the limitations of internal diameter at these end pieces will fully care for this detail of per-

formance. In the meantime if the marking of tubing to show the gas capacity, as proposed in our specifications, is adopted generally by the manufacturers, the matter is adequately cared for.

TABLE 5.—Frictional Resistance of Tubing to Passage of Gas

A. CLASS I SAMPLES.—RUBBER-PACKED JOINT

Sample No.	Approximate internal diameter (inch)	Pressure loss per 6-foot length	
		At 6 cubic feet per hour (inches water)	At 30 cubic feet per hour (inches water)
1	3/16	0.3	.....
2	3/16	.3	.....
3	3/16	.3	.....
5	5/16	.2	2.1
6	3/16	.3	.....
9	3/16	.3	.....
17	3/16	.3	.....
21	3/16	.3	.....
25	1/4	.05	.85
29	1/4	.05	.....
NOT RUBBER PACKED			
49	1/4	0.1	1.6
50	1/4	.1	1.6
51	1/4	.1	1.4
52	5/16	.05	.9
53	5/32	1.75	.....
54	1/4	.20	.....
55	5/16	.15	.....
56	1/4	([a])	.....
57	1/4	([a])	.....
B. CLASS II SAMPLES			
7	1/4	0	0.70
8	5/16	0	.20
10	5/16	0	.60
16	1/4	0.2	2.7
18	3/16	.30	.....
22	3/16	.30	.....
23	1/4	.....	.....
26	5/16	0	.35
28	3/16	.30	.....
34	1/4	.20	2.3
C. CLASS III SAMPLES			
4	5/16	0	0.65
11	3/8	0	.50
14	5/16	0	.45
24	5/16	0	.55
31	3/16	.25	.....
33	1/4	.10	1.70

[a] No test.

6. FLEXIBILITY

The tubing samples which we have tested were kept for several months coiled loosely in a large basket as a convenient means of storage while awaiting test. After they had been coiled in this way for such period it was found that no significant flexibility tests could be made, since the tubing had a permanent "set" in different directions more or less determined by the direction of its bending while stored. It is anticipated that similar difficulty would be met in any case if the samples had not been kept straight until used for the test. For this reason the tests suggested by the committee would often be difficult of application.

The committees' proposed specifications require flexibility of tubing sufficient to permit it "to hang in a graceful, natural curve" from any point of support or attachment. This is perhaps desirable from the commercial point of view, but we can not see any need for making this detail a requirement in the specifications. If the tubing can be bent into a small circle without any apparent effort and will stay tight after such bending it should be flexible enough for most purposes. For uses where great flexibility is essential to good appearance, the customer can select those varieties of tubing which are specially suited to his needs; for general uses the tests in the following modified specifications will guarantee sufficient flexibility.

Although we believe that the importance of the requirement for flexibility has been generally exaggerated, we also believe it is necessary that where a tubing is not flexible it should offer sufficient resistance to twisting or bending that it will not readily be damaged. This idea has been kept in mind in drawing the modified specifications, but because it is so difficult to know just what the hazard is from this source, and also because it is difficult to define a proper test, the suggested requirements have been made very liberal. To require a great degree of flexibility will certainly limit the construction in many ways, and will necessitate sacrificing certain other features which for many purposes would be much more valuable than extreme flexibility. We shall therefore suggest certain specifications for a trial, with the idea of changing the numerical values whenever experience has shown us the need of revision. The same test will take care of the matter of kinking, for which some test was felt to be necessary.

In many cases it would seem absolutely unnecessary to require a tubing to be bent into a 3-inch circle as proposed in the original committee report. Ordinarily as the tubing would be coiled when

out of use, it would be in a circle of about 12 inches; but it would often be bent into a much smaller circle, and tightness when in a 6-inch circle seems a necessary requirement. To provide for sufficient resistance to kinking and leakage of tubing, which can readily be bent into smaller circles, a second requirement is necessary to provide a measure for this feature of strength, and such a requirement is given in paragraph 5 (*b*) of our proposals.

7. HEATING TEST

An electrically heated oven, the temperature of which could be maintained very uniform, was used for heating a number of the samples for 48 hours at 100° F. as prescribed in the specifications. An open vessel of water in the oven kept the air saturated with moisture at this temperature.

Not all the samples were examined in this way, but those which seemed at all likely to show bad effects from such treatment were subjected to test. None of the samples showed serious effects from stickiness or oozing of the composition.

It was desired also to determine what, if any, influence the heating had upon the tensile strength. A temperature of 100° F. for 48 hours would, of course, not be expected to have any appreciable effect on the steel-core samples of Class I, nor even upon those of Class II, which were mostly of rubber. Samples of Class III, which depended for their tensile strength almost entirely on the cotton fabric covered with compound, might be expected to deteriorate on exposure to heat. However, only in the case of sample No. 8 was there any considerable loss in tensile strength; No. 11 was somewhat stronger (probably because of irregularities in the samples) and the others were about the same as in previous tests.

A temperature of 100° F would undoubtedly cause deterioration of such composition layers of glycerin and glue, or of rubber, if continued over considerable periods of time. But it seems that tubing should be able to withstand a considerably higher temperature for short periods, for there is no question but that, in actual use, the tubings are often subjected to considerably higher temperatures.

If 100° F is the limit of heat resistance of ordinary practical tubing, such tubing should be plainly marked and not used where higher temperatures would be reached.

Several tests were made on tubings which were subjected to higher temperatures. At 300° F, tubings Nos. 4, 11, and 14, of

Class III, gave off large volumes of gas and smoke, and after 15 minutes at this temperature the tubings could be picked apart with the fingers. At this temperature the rubber-packed metallic tubings were also ruined within a few minutes. Where the metal was bare, as in sample No. 3, the rubber oozed out of the joints but the tubing did not leak; after the tubing was removed from the oven and allowed to cool, the joints became loose upon further handling. In metallic tubings, covered with composition and cloth, the rubber-thread packing seemed to be protected slightly, but the composition oozed through the cloth covering.

The cloth coverings on all the samples that were tried were readily combustible, so that they quickly took fire upon being brought in contact with a flame. The hazard from such a combustible cloth covering would more than offset any advantage that its presence would give in respect to heat-resisting properties of the tubing, as mentioned in the previous paragraph. In fact, the advantage of the metallic core is largely lost unless the outer fabric layers are reasonably incombustible.

8. FREEZING TESTS

Since gas tubing would seldom be subjected to a temperature as low as 0° F, it seems unnecessary to require it to remain very flexible under such severe conditions. Unquestionably, however, some flexibility should be retained in the tubings at reasonably low temperature; e. g., 32° F, for otherwise the composition may readily be broken when a cold sample is bent. We believe, therefore, that reasonable flexibility requirement should be fixed for 32° F and are so recommending in our specifications.

9. RUBBER SLIP ENDS

End pieces from the same lot of tubing used for the tubing tests were used for tests. The numbers given to the end-piece samples correspond to the numbers of the tubing samples. These were tested for tensile strength and percentage elongation at break. The strength is shown both in terms of pounds per square inch of cross section of rubber and for the whole end piece calculated for the point of minimum rubber cross section. These end pieces had been stored for about a year and a half and probably had deteriorated slightly, but for that very reason the samples should be more representative of average material which the buyer would get.

The results given in Table 6 bring out strikingly the wide difference in the quality of the various rubber end pieces, and when one considers that probably the greatest source of hazard from gas

tubing is from the defective end pieces it seems that a small additional cost should not prevent the adoption of the better quality. The necessity for a high-grade end piece is especially important until there is some uniformity and standardization of the size of hose-end nozzles. If the nozzle was always the correct size for the particular end piece, so that there would be no undue strain or stretching of the rubber, a much smaller degree of flexibility and strength would be needed.

TABLE 6.—Tests of Rubber End Pieces—Tensile Strength and Percentage Elongation at Break

Sample No.	Tensile strength		Percentage elongation at break
	Pounds per square inch of rubber cross section	Pounds for the end piece for minimum cross section	
1	944	462	450
	970	475	400
	1320	650	500
4	98	29	50
5	103	33	100
6	510	100	250
			200
11	165	64	50
			50
24	167	65	50
			50
34	165	60	200

The specifications proposed in this report are not based upon these tests of aged end pieces, but upon other work with new rubber which will very readily, if of good grade, comply with our recommendations. In fact, very much more severe specifications would be commercially possible, but at present such greater severity seems unnecessary.

10. DETACHABLE METAL END PIECES

The detachable metal end pieces appear very promising, and if the ends of the tubing are properly prepared for these end pieces they should be very satisfactory. The tightness depends entirely upon a rubber ring which forms a gasket between the two metal parts and by being thus squeezed is forced against the tubing. With the bare metal tubing it seemed impossible to force the rubber ring into the corrugations of the tubing sufficiently to make a gas-tight joint. With one of the composition and cloth-covered tubings a practically tight connection was made, but a larger tubing of this same kind leaked considerably.

TABLE 7.—Summary of Tests

CLASS I.—TUBINGS WITH METALLIC CORE

Sample No.	Approximate internal diameter (inch)	Pressure loss per 6-foot length (inch water pressure)		Crushing load (pounds per linear inch)	Tensile strength (pounds)	Pull to remove end piece (pounds)	Leakage (thousandths cubic foot per hour per 6-foot length)
		At 6 cubic feet per hour	At 30 cubic feet per hour				
1	3/16	0.3	.....	525	180–280	110–150	5– 9
2	3/16	.3	.....	700	238–200	130– 90	0
3	3/16	.3	.....	400	78– 90	64– 65	2– 6
5	5/16	.2	2.1	300	248–240	160–118	24–48
6	3/16	.3	.....	700	172–180	80– 80	10–30
9	3/16	.3	.....	600	350–350	125–160	3– 6
17	3/16	.3	.....	700	220–220	148	0
21	3/16	.3	.....	750	175–200	146	2– 7
25	1/4	.05	.85	400	240–248	250	0– 3
29	1/4	.05	.....	280	136–130	35	(a)
49	1/4	.1	1.6	500	70– 60	(b)	0
50	1/4	.1	1.6	700	1370	(b)	0
51	1/4	.1	1.4	500	80	b 46	0
52	5/16	.05	.9	450	60– 80	(b)	0
53	5/32	1.75	.....	435	70	(b)	0
54	1/4	.20	.....	800	380	(b)	0
55	5/16	.15	.....	770	80	(b)	0
56	1/4	(c)	(c)	685	90	52	.....
57	1/4	(c)	(c)	.....	.....	.....	0

CLASS II.—TUBINGS WITHOUT METALLIC CORE BUT WITH SOME RUBBER

7	1/4	0	.70	150	104–100	100	3
8	5/16	0	.20	10–10	48– 48	.....	3–7
10	5/16	0	.60	200	68– 70	60–80	2–6
16	1/4	.20	2.7	25–17	110–100	72–46	0–2
18	3/16	.30	.....	150	108–120	106–110	0
22	3/16	.30	.....	20	82–62– 80	(b)	0
23	1/4	.....	.....	180	100	.....	.....
26	5/16	0	.35	200	72– 74	50	(a)
28	3/16	.30	.....	30	68–66– 82	(b)	0
34	1/4	.20	2.3	125	130–70– 62	(b)	.....

CLASS III.—TUBINGS WITHOUT METALLIC CORE OR RUBBER LAYERS

4	5/16	0	.65	135–100	60–78–70–53 62–58	(b)	1–9
11	3/8	0	.50	130– 65	100–105	74–80	0–2
14	5/16	0	.45	130	40–58–49–55 50	(b)	(a)
24	5/16	0	.55	180	190–218	.....	.....
31	3/16	.25	.....	370	215–210	118	2
33	1/4	.10	1.70	190	195–180	168	14–18

a Leak in connection. b Tubing broke before end pulled off. c No test.

From the above it appears that bare metal tubings and those covered with a loose cloth covering need to have the ends prepared in some way to assure a gas-tight joint. The strength of the joint is ample, as shown by the following tests, where the joint was made up with the fingers without any tools. Sample No. 6, an uncovered metal tube, broke at 80 pounds pull; but the tubing was damaged before the end pulled off. Sample No. 7, a $\frac{3}{16}$-inch covered tubing, and No. 8, a $\frac{5}{16}$-inch covered tubing, broke at 130 and 100 pounds, respectively.

V. DISCUSSION OF RESULTS

The specifications for the construction of tubing may well be definite in certain details, but it is essential that they be so worded that they are minimum specifications; that is, permitting nothing inferior to the standard, but allowing as much better construction as the maker may wish to afford. Furthermore, it seems desirable that there be included as a guide to the makers of tubing, suggestions as to the preferred grades or details of construction, which are not yet required but which may in later requirements be made compulsory.

The original proposals of the committees went far beyond this point in their detail, for they limited the makers to one class of tubing. This appears to us to be undesirable for several reasons, as follows: (*a*) A specific requirement prevents the exercise of ingenuity by the makers; (*b*) it precludes changes in construction which might greatly reduce the cost of manufacture, even though this were found to be practicable without detriment to the performance of the tubing; (*c*) it does not provide the desirable variety of styles of tubing for various uses; and (*d*) it may tend to support unduly one or more makers who are especially well equipped to supply at low cost the style of material covered, to the disadvantage of other makers who may be able to supply other styles which are substantially as good.

The object of any specifications for flexible tubing is obviously the elimination of the more dangerous types and the encouragement of use of the best available forms. It appears that too definite or limited specifications may defeat their own end by making it impracticable to expect full compliance at the outset. In our judgment, therefore, it is better that a number of varieties of tubing be permitted, at the outset at least, since it is probable that it would be utterly impossible to supply the entire demand for tubing with any single style, no matter how good it might be.

Then it would be expected that revisions of the specifications would gradually make them more rigid, so that eventually only the highest grades would be permissible under these requirements.

It does not appear to us that there is any one style of tubing that can properly be said to be far superior to all others, and until such tubing is available it would seem best to base the specifications largely upon the performance of the tubing. The required performance will in some cases be expressed in very specific form and be susceptible of determination by test; in other particulars the requirements will have to be general in nature, either because of the limited amount of information thus far available or because it is impracticable to make tests of the characteristics in question.

In addition to the specifications for performance as already discussed in the sections where the test results are presented, we think that some consideration must be given to the following details of construction which are of some importance in securing the best grades of tubing.

1. In general, a noncombustible metal base for the tubing is desirable, but it should not be required for all classes of tubing. If it is not used, some alternate form of construction to secure the required strength, resistance to crushing, and durability is, of course, essential. It is also very desirable that the alternate construction be such that the tube will not readily be burned or melted apart sufficiently to allow the gas to escape in large quantities, even when subjected to somewhat excessive temperatures.

It must be recognized that with the exception of some of the new varieties of all metal tubings, the tubings in general use can not be considered noncombustible. A temperature of 300° F. is sufficient to melt or dry out the rubber packing and although no immediate leaks may occur, the tubing is practically ruined and a source of danger subsequently. A combustible cloth covering introduces an additional hazard which could be eliminated by a slight expense in fireproofing the material.

2. It does not seem desirable that the precise nature of the metal core of the tubing be defined by specification since any construction meeting the requirements as to performance would be acceptable. For this reason the requirements of "one unbroken strip of metal," "wound spirally," "an interlocking seam," and "a continuous rubber thread-like gasket" appear inexpedient. Splicing of lengths should, however, be forbidden.

3. The uninformed user of tubing will often allow tubing to come in contact with the hot parts of the appliance with which it is used, if it seems from its appearance that this will do no damage. Therefore, if a tubing is made to appear fireproof, it is essential that it be actually of such nature that ordinary use in work that exposes it to rather high temperatures will not produce serious deterioration.

4. When any composition layers, such as those made from glue or glycerine mixtures are employed, they should be adequately wrapped with paper or cloth layers to prevent mechanical damage during ordinary use and to prevent any stickiness or softening from heat or moisture under ordinary conditions.

5. Tubing which is constructed with layers of rubber composition, and which is dependent primarily upon this for strength and tightness, should preferably be made up with fabric incorporated in the rubber layers, after the fashion of garden hose. The rubber must, of course, be made up in a high-grade and durable composition.

6. For tubing which is specially constructed for use with gas irons, it is very desirable that at the end near the iron there be a reinforcing spiral wire, sleeve, or other support. This will prevent damage to the tube from the repeated bending at one point which is likely to result unless special precautions are taken to distribute over an appreciable length of the tube the bending that necessarily occurs during the use of the iron.

7. It does not appear that a specification intended primarily to cover safe construction of tubing need include requirements as to the color or nature of the outer fabric layers. Unquestionably it is desirable that the cover be dyed with a fast color, but such details will be determined by the makers in accordance with commercial demands and can properly, therefore, be left to them for decision.

8. The proposed requirement of dimensions of tubing recognizes the probable need for other sizes in addition to the three specifically mentioned, and we believe that the rule must be so loosely drawn that any size can be manufactured. There is some advantage in uniformity of sizes in order that it may be easier to fit the end pieces and ferrules to tubings of different makes; but there does not appear to be sufficient advantage in any such rule as to justify including this requirement in the general specifications.

9. It is highly desirable that the purchaser be able to determine the quantity of gas which any sample of tubing will deliver, so that he may purchase an appropriate material. However, the external diameter is a poor guide to this determination even when there is some limit as to the relation between inside and outside dimensions, because usually neither the customer nor the sales person is competent to estimate the gas capacity even from inside dimensions. It is believed that some marking of gas capacity would be desirable, and it is included as a recommendation in the revised specifications.

10. In order to make the manufacturers of tubing responsible to a greater degree for their product, it seems desirable that the maker's name be indicated on the tubing even up to the time it reaches the user. This may be accomplished by markings on the metal or rubber ends or by a small tag attached to each length of tubing. This practice is recommended in the revised specifications.

VI. MODIFIED SPECIFICATIONS PROPOSED

The following modified specifications are presented for further consideration. It is believed that they will permit several of the better classes of tubing, but that a large percentage of the inferior grades, including all those which seem inherently objectionable from the standpoint of safety, will be precluded. In a number of instances it is still impossible to draft the proper rules to cover features which must be taken into account in the complete specifications. In some such cases only the need for the rule is indicated; in others the rule is proposed in a general form, suitable for tentative adoption, with the idea that more definite specifications can later be formulated to supersede this preliminary regulation.

As pointed out above these recommendations are not considered as final in any sense, but are submitted for criticism and comment. The Bureau of Standards will therefore welcome communications from all interested parties.

Tentative Specifications for Flexible Gas Tubing

[Proposed for criticism and comment]

Flexible gas tubing which is made and sold to the general public for use with city gas or for similar purposes shall conform to the following specifications of construction and performance.

I. GENERAL CONSTRUCTION

(*a*) In general, tubing as offered for sale to the general public shall be made up of suitable lengths of flexible tube with end pieces of rubber or metal already attached.

It is recommended that there be no general sale by retailers of long lengths and separate end pieces which it is intended that the user will assemble for himself. Furthermore, it is recommended that makers of end pieces or of tubing do not sell their product unless in complete assembled form, except to dealers whom it is known have facilities for and intended to perform properly the work of assembling.

(*b*) If tubing is made to appear to the user to be fireproof or substantially resistant to heating, then it shall actually be made so resistant to high temperature that such contact with the hot parts of an appliance or the hot products of combustion of gas as may readily occur will not cause it to leak or be otherwise seriously defective.

2. NATURE OF VARIOUS LAYERS

(*a*) *Metal Core.*—It is recommended that a strong and substantially gas-tight metal core shall be used for all tubing intended for sale to the public for general uses. The rubber threadlike packing, which may be used to make such core gas-tight, shall not be the sole means for preventing leakage, but a layer of rubber, composition, or other suitable gas-tight material must also be employed. Provided, however, that if the metal core is made up to be of itself gas-tight, or is made so with suitable non-combustible packing, then this outer layer of rubber or composition, though often desirable, is not always required. Splicing of the metal core shall be avoided whenever practicable; when necessary it must be done in such manner as to leave the tube as strong and tight as an unspliced section.

(*b*) *Rubber Layers.*—If layers of rubber compound are used, they shall have incorporated in them or closely adherent to their surface suitable fabric layers. When such layers of rubber compound are used without metal core, even though a reinforcing wire helix be used, it is recommended that several layers of strong fabric be incorporated in the rubber to give a construction similar to that of garden hose. The composition of rubber layers should be suitable and vulcanization adequate so that no deterioration causing leakage or serious loss of flexibility will occur during ordinary careful use for a period of at least two years.

(*c*) *Composition Layers.*—Any composition layers, for example, those containing glue, glycerine, or similar materials, shall be so made that they will resist all ordinary service without cracking, oozing, or becoming sticky.

(*d*) Tubing made up without either metal core or rubber layer such as recommended in (*b*) must not be sold.

3. LABELING

(*a*) It is recommended that each length of tubing offered for sale be labeled with the name and address of the maker by suitable marking on the end connections or by a small tag attached to the tubing, or both.

(*b*) It is recommended that each length of tubing be marked clearly to show the maximum rate of gas flow for which it is suited. For this purpose the rating shall be based upon the cubic feet per hour of gas of specific gravity 0.60 which will pass through the tubing, including the end pieces, with a loss of pressure of not greater than 5/10 inch of water.

4. STRENGTH

(*a*) The tubing shall be so resistant to crushing that it will support a transverse load of 100 pounds per linear inch without either permitting a leakage of gas or collapsing enough to shut off the flow of gas.

(*b*) The tubing shall be capable of withstanding without leaking either during or after the application of the load a steady lengthwise pull equivalent to a weight of 75 pounds.

(*c*) The tubing shall be capable of withstanding without leakage either during or after the test a twisting movement acting clockwise or counterclockwise sufficient either (1) to produce an angular deflection of 180° per foot of length, or (2) to produce a strain equivalent to that given by a 2-pound weight at the end of a lever 12 inches long.

5. FLEXIBILITY

(*a*) The tubing shall show no increase in leakage when bent into a circle 6 inches in diameter, if tested in accordance with paragraph 6 (*b*), either (1) at once after such bending; or (2) after being so bent for 20 minutes; or (3) after straightening the tube following a period of 30 minutes in the bent position.

(*b*) The tubing shall be of sufficient strength to resist without damage or kinking a pull applied at the ends of the tube at least as great as shown in the following tabulation:

Smallest circle into which tubing can be bent without leaking or kinking	Maximum pull on ends which tubing must resist when formed into a loop and pulled into a circle of size indicated
3 inches or less	2 pounds weight
3 to 4 inches	4 pounds weight
4 to 5 inches	6 pounds weight
5 to 6 inches	8 pounds weight

(*c*) The tubing shall retain its flexibility at low temperature sufficiently that after being kept at 32° F. for 6 hours it will pass the bending test prescribed in the preceding paragraph.

6. TIGHTNESS

(*a*) The tubing shall be sufficiently gas-tight so that a 6-foot length, including the end pieces, shall show a leakage of not more than 0.02 cubic foot of gas per hour.

(*b*) The test for tightness shall be made as follows: One end of the tube shall be connected to the outlet of a gas meter graduated to read to 0.001 cubic foot and with the other end stoppered the tube shall be subjected to a gas pressure of 6 inches of water for a period of at least 5 minutes.

7. RESISTANCE TO HEATING

(*a*) Tubing shall be so resitant to heat that it will not soften sufficiently to become sticky or for any part to ooze out through the paper and fabric layers when the tubing is kept for 24 hours at a temperature of 125° F. in an atmosphere saturated at that temperature with water vapor.

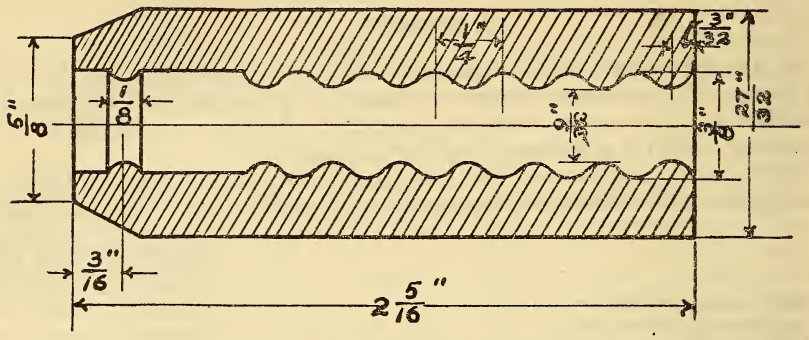
8. RUBBER SLIP ENDS

(*a*) If rubber slip ends are used they shall be made of rubber compound of the following characteristics:

1. *Material.*—The rubber ends shall be made from a properly vulcanized compound containing not less than 60 per cent by volume of Fine Para or best grade Hevea-Plantation rubber. The sulphur available for vulcanization shall not be over 8 per cent of the weight of rubber present. The remainder of the compound shall consist only of inorganic material. No rubber having previously been vulcanized shall be used. (This is approximately equal to a minimum of 35 per cent by weight of rubber and a maximum of 2.8 per cent by weight of sulphur for vulcanization on a compound of 1.6 specific gravity.)

2. *Physical Properties.*—The rubber shall show upon testing a tensile strength of not less than 1200 pounds per square inch; an ultimate elongation of not less than

350 per cent; and a permanent set of not more than 25 per cent after having been stretched 300 per cent for 10 minutes and then allowed to rest for 10 minutes. (One lot of specimens shall be tested for strength and elongation which have not been previously stretched and a separate lot of specimens shall be used for the set test.)



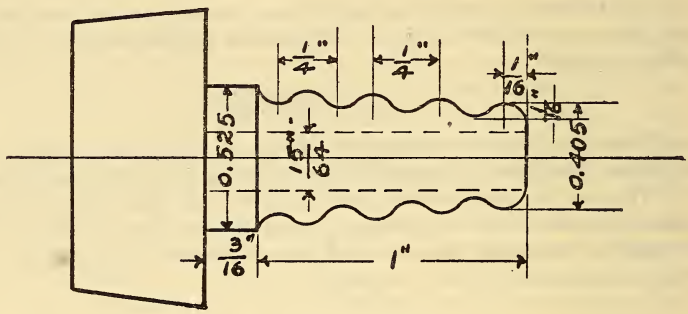


FIG. 4.—*Design for standard hose end nozzle and standard rubber hose end*

Proposed by Committee on Standardization of Gas Appliance Specifications

3. *Methods of Testing.*—All physical and chemical tests shall be performed according to the standard procedure in use at the Bureau of Standards, described in the latest edition of Circular No. 38 of the Bureau.

(*b*) The rubber slip end shall preferably be shaped in accordance with the Fig. 4; but any other shape may be used if it can be conclusively shown to be of substantially equivalent value.

9. ATTACHMENT OF SLIP ENDS OR FITTINGS

The joint between the slip end and the tubing shall be so tight and strong that it will withstand the tests prescribed for the tubing itself in the following particulars: Tensile strength (paragraph 4 (b); twisting (paragraph 4 (c); and tightness (paragraph 6 (a) and (b).)

FIG. 5.—*Merchant's permit card*

APPENDIX.—GAS-TUBING INSPECTION IN NEWARK, N. J., BY ELLSWORTH FRANCISCO [1]

During the latter part of December, 1916, two young men, residents of the city of Newark, were asphyxiated by illuminating gas that escaped from a piece of brown-paper gas tubing connected to a portable heater in their bedroom. Accidents chargeable to gas tubing had happened from time to time in years past without causing any unusual official alarm, but this particular occurrence and the obvious danger of such flimsily constructed gas tubing so appealed to the county prosecutor who then held office that he demanded some immediate action by the city of Newark to protect the public against this cheap, dangerous kind of tubing, with the result that a municipal ordinance prohibiting the sale and use of other than approved tubular connections for illuminating-gas fixtures and appliances became effective in this city March 13, 1917.

This ordinance simply provides, "That it shall be unlawful for any person, persons, firm, or corporation to use, sell, expose, or offer for sale, to install or affix, in the city of Newark any tubular connections or fabric intended for any illuminating-gas fixture, stove, heater, lamp, or other gas appliances, unless such tube connection, hose, or similar device shall have been approved by the inspector of gas and gas meters of the city of Newark," and makes it the duty of five city departments to cooperate in enforcing the regulations established by the inspector of gas and gas meters.

When the ordinance was under consideration it seemed impossible to find any municipal or governmental laws that would serve as a guide to us, therefore it was thought advisable to leave out any specific mention of standards so that the ordinance might be flexible, and enable us to establish such regulations and standards as general conditions might warrant from time to time, and change these until we obtained the largest measure of protection to our citizens.

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[1] The following report of the work done by the city of Newark in order to regulate the quality of tubing sold within the city has been prepared by Mr. Ellsworth Francisco, who has been in charge of and responsible for the development of the very effective inspection service in that city. The authors wish to acknowledge Mr. Francisco's courtesy in the preparation of this section, as well as to express their appreciation of the suggestions which he offered from time to time during the course of the Bureau's work.

General publicity was given the ordinances and the regulations thereunder established, through newspaper articles, public exhibits, and demonstrations, talks to public-school classes, and the requirement that the merchants publicly display their permit cards.

In order to put some immediate regulations into effect we decided to set our first standards merely upon a more or less commonsense basis, and to study our subject as we went along with the view of raising our standards gradually until eventually only the best tubing would be permitted to be offered for sale.

Since the obvious danger from tubing made chiefly from layers of paper first attracted out attention, this with its several variations was unqualifiedly disapproved. Tubing with a wall of gelatine compound less than 1/32 of an inch thick, common rubber and pure gum hose (the kinds usually used for syphoning wine, etc.), and rubber made for use as gas hose without an outside coating of gelatine compound were also prohibited from sale. Defective tubings of all kinds were condemned, and uncovered rubber tubing made similar to garden hose with layers of canvas incorporated between the layers of rubber was approved for industrial purposes only. All other kinds of tubing intended to convey gas were tentatively approved until further notice.

1. ENFORCEMENT OF ORDINANCE

Our first step in enforcing the ordinance was to take from the City Directory the names of all wholesale and retail merchants whom we believed would be apt to handle gas tubing, and send to each a copy of the ordinance and a notice stating that they would be required to submit at once to the inspector of gas and gas meters for approval a sample of each kind of tubing that they carried in stock and intended hereafter to offer for sale in this city.

Prompt response was obtained from about 50 per cent of the notices and within a period of 60 days all but about 10 per cent had been answered. These latter cases required a personal visit from an inspector and he found that only two or three of these merchants were willfully trying to evade the provisions of the ordinance. We feel very much gratified with this prompt response.

It was desired to have the merchants come to us for the first inspection so that we could have an opportunity to fully explain the protective purposes of the ordinances and the benefits derived

therefrom by both the public and themselves. Then, again, we were able to get the merchants' whole attention at our laboratory which would have been practically impossible at their place of business. Inspections and examinations are now made of gas tubing stocks at the merchants' place of business by a regular inspector who is employed for this purpose.

2. PERMIT TO SELL TUBING

Every merchant who desires to sell gas tubing, whether retail or wholesale, is required to obtain without charge from our bureau a permit issued in the form of a public display card, such as shown in Fig. 5. This card bears, along with the printed matter, the merchant's name and address, an identifying number and the date issued, and attached to the lower half is a sample of each kind of approved tubing which the merchant desires to sell. No kind of gas tubing other than the samples approved on the permit card can be carried in stock or offered for sale at any time. A new card is issued every year.

Each merchant makes his own selection of the kinds of approved tubing that he desires to handle, without any advice or criticism from this bureau, except that we endeavor to induce each dealer to handle at least one of the better types of tubing if his original selection does not include any of these. In addition to our desire to induce the general public to buy the better types of gas tubing we are trying to prepare the gas tubing users for the time, which we hope is not far distant, when they will be able to purchase only the best types of gas tubing in the city of Newark.

We have at present 230 retail merchants and 2 wholesale dealers selling gas tubing. Fully 90 per cent of these merchants now handle uncovered metal tubing, many exclusively, and the remaining 10 per cent handle a variety including the better types.

3. REGULATIONS AND TESTS

It was intended at the beginning of our work to immediately prohibit, without warning, the sale of the paper types of gas tubing, but it was found that this rule would be rather unfair to the merchants and cause them a financial loss, considerable in some cases, therefore three months' time was given the merchants starting from the date the ordinance became effective to dispose of their stock of disapproved tubing in anyway possible.

At the end of this time a special corps of inspectors were sent out to inspect every merchant's stock of tubing and bring in for

reexamination all tubing that did not correspond to the samples attached to their permit cards. This inspection resulted in a confiscation of 271 pieces of disapproved tubing, totaling 1032 feet. Some of the confiscated tubing is shown in Fig. 6. The entire premises was searched and disapproved tubing was found under counters, in back rooms, and on the regular tubing racks. Since this raid only a few lengths have been brought in by our regular inspectors, mostly from new merchants who professed to have no knowledge of our tubing regulations.

Since January 1, 1918, our retail merchants have been absolutely prohibited from having in stock or offering for sale separately rubber ends for gas tubing or carrying in stock any quantity of stock of gas tubing for the purpose of making up complete lengths for customers at the time of sale. This makes it necessary for retail merchants to purchase their supply of tubing in complete lengths with rubber end pieces attached either by the manufacturer or wholesaler.

Approved gas hose display cards must at all times bear a sample of each kind or type of gas tubing offered for sale and must be publicly displayed near the merchant's tubing rack. The Municipal Gas Tubing Bureau approves of types or kinds of gas tubing as a whole, not each piece or length offered for sale. Each dealer must be held responsible for the condition of the tubing he sells, therefore we suggest and ask that each retail dealer make the following tests on every length of flexible gas tubing just before it is sold to the customer.

Strength Test.—Take a firm grip on each end of the piece of tubing and pull with a lengthwise strain on the tubing equal to that exerted by lifting a 75-pound weight from the floor, if the tubing breaks apart or the rubber ends come off or the tubing leaks in the last test, reject it.

Rubber End Test.—Grip both rubber ends in turn, between thumb and fingers where they are fastened to the tubing and give the rubber end a fairly hard twist; if the ends become loosened or leak in the next test, reject the tubing.

Leak Test.—Make the final test for leaks in the same manner as that now made by you, and reject all tubing that will not stand these tests.

Defects.—Examine the rubber ends and the tubing for other defects than those specified. Never sell a defective or leaky piece of gas tubing to a customer, it might be the means of caus-

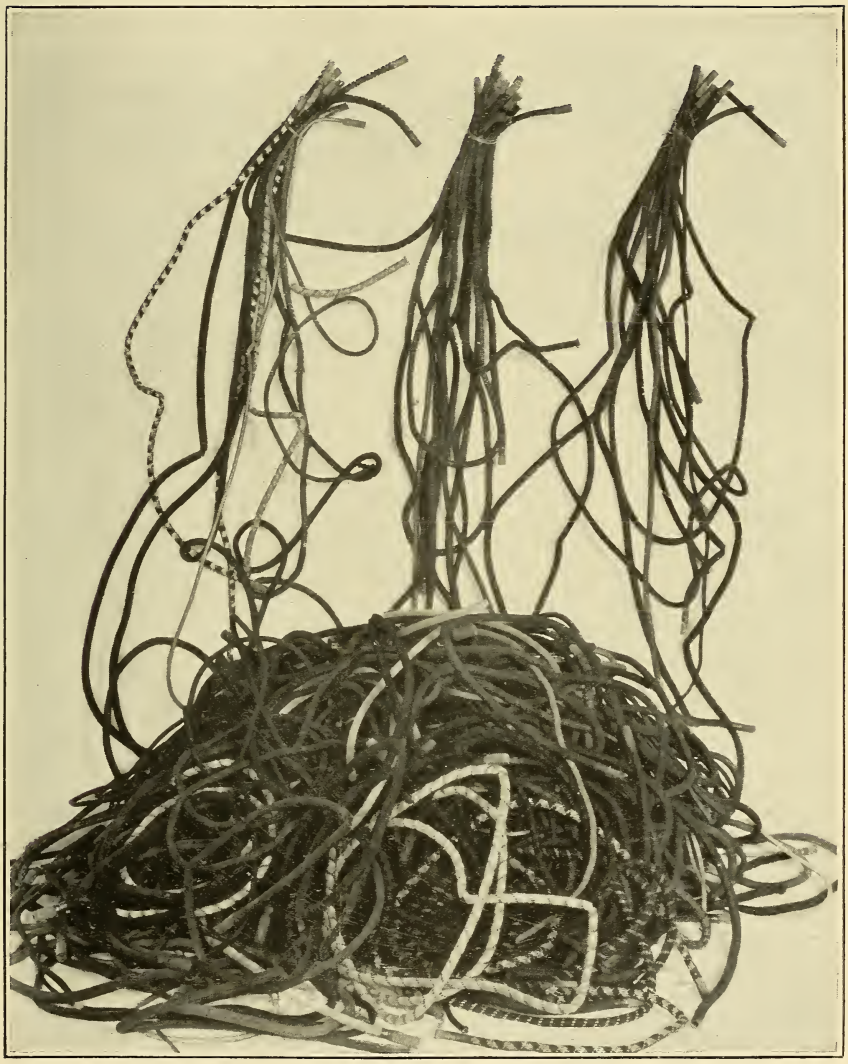

FIG. 6.—*Quantity of disapproved gas tubing confiscated by the city of Newark, N. J.*

ing asphyxiation, fire, or other serious damage from the gas that leaks from the tubing.

The governing officials and the inspector of gas and gas meters desires to take this opportunity to acknowledge with our many sincere thanks the invaluable aid given by the Federal Bureau of Standards through their kindness in permitting us to study the information contained in their report on Flexible Gas Tubing Tests before it had been made public, and to Mr. R. S. McBride, engineer chemist, of the Federal Bureau of Standards for his untiring personal interest and good advice.

4. AN ORDINANCE PROHIBITING THE SALE AND USE OF OTHER THAN APPROVED TUBULAR CONNECTIONS FOR ILLUMINATING GAS FIXTURES AND APPLIANCES

Be it ordained by the common council of the city of Newark, as follows:

SECTION 1.—That it shall be unlawful for any person, persons, firm, or corporation, to use, sell, expose or offer for sale, to install or affix, in the city of Newark, any tubular connection or fabric intended for any illuminating gas fixture, stove, heater, or lamp, or other gas appliances, unless such tube connection, hose, or similar device shall have been approved by the inspector of gas and gas meters of the city of Newark.

SEC. 2. It shall be the duty of the Board of Health of the city of Newark, its officers and employees, the superintendent of buildings, the assistant superintendents of buildings, the police officers of the city of Newark, the Bureau of Combustibles and Fire Risks, and the said inspector of gas and gas meters of the city of Newark to enforce the provisions of this ordinance.

SEC. 3. Any person, firm, or corporation which shall be convicted of a violation of this ordinance shall forfeit and pay a penalty of twenty dollars ($20) for each offense.

SEC. 4. All ordinances and parts of ordinances inconsistent with the provision of this ordinance be, and the same are hereby, repealed.

SEC. 5. This ordinance shall take effect immediately.

Adopted March 3, 1917.

WASHINGTON, March 25, 1919.