COMPARISON OF THE RESISTANCE TO WEAR OF CREPE DE CHINE, SATIN CREPE AND RAYON

by

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PURPOSE

The purpose of this research was to devise an experimental method for testing the resistance of clothing fabrics to wear, and to test the method as far as the available time would permit.

It was decided to confine the tests to Crepe de chine, Satin crepe and Rayon* coat linings.

RESUME' OF PREVIOUS WORK DONE

The only machines which have been used for abrasion of textile fabrics, so far as the writer is aware, are those used in the United States Testing Co., Inc., New York; the Bureau of Standards, Washington, D. C.; Massachusetts Institute of Technology, Cambridge, Mass.; and one in use in the Textile laboratory, at this college.

Those in use at the U. S. Testing Co., Inc., New York, are described by W. F. Edwards in the Textile World for June 5, 1926.

The reciprocating blade type of wear tester produces

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*Throughout the thesis, rayon is the term used for a rayon and cotton union goods. (See analysis Table II.)

wear on a ribbon-like sample of the fabric maintained at a constant tension by means of a known weight acting over a pivoted roller. The abrading surface consists of a number of steel blades mounted on a cylindrical roller somewhat as cogs in a cogged wheel. This cylinder, with its blades, was made to revolve alternately clockwise and anti-clockwise by means of a pitman which operates a cogged gear.

A simplified form of the above device was also used. In this type of machine the steel blades were thicker than those in the previous type and the cylinder was made to revolve always in the same direction.

In a third type of machine used, the sample of fabric was maintained under constant tension in a manner similar to that in the first type with the exception that the tension weights were attached to each end of the sample. The sample was bent and abraded on both sides at the same time. The bending was produced by revolving eccentric circular steel disks, while the abrasion was produced by the simultaneous reciprocating motion of the same disks.

A fourth type of machine used was a reciprocating device, the abrading surface in which was emery cloth tape operated in such a way that new portions of the tape could be used for each test. The fabric to be tested was placed on a smooth surface under the constant tension of a coiled

spring.

The amount of wear in the above experiments was judged both by inspection and by breaking force.

Mr. Charles W. Schoffstall, chief of the Textile Section of the Bureau of Standards, mentions in the Textile World of November 5, 1927, the one used at the Bureau of Standards. The machine used was a wear testing machine for testing the wear on carpet and was based on the leather wear testing machine described in the Bureau of Standard Technologic Paper No. 147.

The result was interesting chiefly from the standpoint of indicating the further work necessary for its success.

The machine used by the Massachusetts Institute of Technology was described in Textile World, August 6, 1927, by E. R. Schwarz. Fine emery cloth was used as the abradant and breaking strength was taken as a measure of wearing quality.

"It consists of a cranked pulley taking its power from a variable speed line shaft and connecting, by means of a steel tape passing over pulleys, with a frame which oscillates in guides. The lower member of the frame has its upper edge rounded to a 3/32 inch radius. The upper serves as a guide for guard posts of the abrading bar and are adjusted to rock back and forward at the time of change in direc-

tion of the stroke. This keeps lint from accumulating and minimizes the suddenness with which the abradant bites into the fabric at the beginning of the stroke.

To the under surface of the bar is attached emery cloth No. 000. This, due to its position tangent to the curvature of the bar, rubs the fabric on an elementary line as nearly as can be obtained and thus as the fabric is passed beneath it by the motion of the frame the surface is uniformly abraded. The tension system allows the use of a number of weights. A counter is provided to record the number of strokes. The stroke is approximately six inches."

During the summer of 1926 an abrasion machine was designed and constructed in the Physics shop at this college.

The machine was a table under which was placed the mechanism necessary to convert the rotary motion of an electric motor to a reciprocating motion. On top of the table was placed the two glass plate surfaces on which was clamped the fabrics to be tested. A crank, operated by the fly wheel moved a block back and forth on steel guides. A vertical steel shaft attached to this block transferred the reciprocating motion to the rubbing block above the table. This block, carrying the abradant, which was a piece of heavy cloth, rubbed across the sample to be tested and was held together with a definite pressure exerted by weights

placed on top of the rubbing block.

The wear was judged by inspection and per cent loss by weight.

As a result of this experimental work it was discovered that the wear of all the fabrics was influenced to a more or less degree by certain factors, namely;- temperature and relative humidity of the air where the abrasion was done; pressure holding the two fabrics together; the tension of the sample being rubbed and the rate of rubbing. All these were given consideration when the machine was designed upon which the following piece of work was done.

OUTLINE OF THE METHOD

The method used in performing this experiment is that of subjecting the lining, under test, to wear against serge in such a manner as to maintain constant the factors, relative humidity; temperature; pressure holding the two fabrics in contact; tension of fabric tested and the rate of rubbing the two fabric surfaces in contact.

The amount of wear is tested at intervals of a suitable number of thousands of rubs, by subjecting the worn sample to a breaking test.

The data obtained for each kind of fabric was plotted

in the form of curves having breaking strength as ordinates and the corresponding number of thousands of rubs as abscissae.

It is now possible, by means of the curves thus obtained, to compare the three fabrics used with respect to their resistance to wear.

DIAGRAM AND DESCRIPTION OF APPARATUS

The apparatus, as a whole, used in the experiment is shown in Fig. 1.

Side Elevation

Fig. 2 shows the side elevation of the apparatus, the essential features of which are as follows. The lower deck supports a motor, M 1, which drives a fly wheel, F1 by means of a belt. A crank, at the top of this fly wheel operates the reciprocating block, B1, by means of a pitman Pt. The vertical rod, A, fastened to the block B1 carries an arm, E, at its upper end. This arm, E, is adjusted at any point on the rod, A, by means of a set screw and operates the reciprocating rubbing block, R, on the shaft of which the pressure weights, Wt, rest. A pulley on the fly wheel shaft al-

so rotates the vertical rod, D, which operates the water pump, Wp, and also the revolving rubbing plate, W 1. The revolution counter, Rc, is operated by the vertical shaft of the fly wheel, Fl.

J is the nozzle of a water aspirator for supplying moisture to the space in which the rubbing is done. H is a carbon lamp for supplying heat to the space. F is an electric fan for the purpose of removing lint from the fabric and for keeping the air in motion. V is a metal-lined drawer, holding calcium chloride, the surface of which may be exposed by withdrawal of the grooved lid. The triangular block, K, when turned with the vertex upward raises the rubbing block, R, from the cloth.

The belt driven water pump, Wp, pumps water from the rectangular vat below the pump through a water cooler in the conditioning vat, then through a water cooler, W, and finally through the revolving metal box, W 1, on the top of which the fabric is rubbed. After passing W 1, the water is conducted by means of a drip pan back to the vat.

Plan Of Upper Deck

Fig. 3 shows the plan of the upper deck of the machine. As may be seen from the side elevation, the upper deck is

provided with a double glass top which can be removed and also a double glass side wall, the remaining walls being wood. S represents spring balances which by the aid of pulleys and flexible cords, hold the fabric to be rubbed at the necessary tension. The posts, G, serve as guides between which the arm, E, moves. Q is a rectangular clamp operated by two screws which hold the fabric on the reciprocating rubbing block. T 1 is a dry bulb thermometer and T 2 is a wet bulb thermometer which carries its own water receptacle and wick. L represents wood posts between which a wire is stretched that holds control samples of the fabric being tested. The sliding block, B, shown in Figs. 2 and 3 prevents air and moisture from passing either in or out of the upper deck enclosure through the slot in the floor, through which the vertical rod, A, operates. The remaining features are obvious either from Fig. 3 or Fig. 2.

Plan Of Lower Deck

Fig. 4 shows the plan of the lower deck of the apparatus. The essential features of which may be understood by means of the lettering which corresponds to that of the side elevation plan.

Side Elevation Of Conditioning Vat

Fig. 5 shows the side elevation of the enclosure which was used for the purpose of conditioning the samples for the various tests. The vat consists, essentially, of an air and water-tight box, of water proofed wood, with a double glass removable top. C and B are respectively dry and wet bulb thermometers. A represents the aspirator which supplies the air in the vat with moisture. D is a calcium chloride drying box similar to that shown at V in Fig. 3. E is a triple cavity metal box through which water may be made to circulate for the purpose of lowering the temperature of the air. F represents two baffle plates of metal between which a carbon lamp supported in the wall is placed. H represents an electric fan operated by means of a motor driven metal shaft which passes through the wall of the box. The rectangle and the two squares in the upper part of the box represent samples of fabric in the conditioning process.

Plan View Of Conditioning Vat

Fig. 6 shows the arrangement of the essential features lettered and described in Fig. 5 as viewed from the top of

the conditioning vat.

Vertical Section Of The Revolving Rubbing Plate

Fig. 7 shows the essential features of the device used for maintaining the metal plate, B, which holds the sample to be rubbed at constant temperature. Water from the pump enters the tube I from which it is conducted into the cavity below the plate B; after filling the cavity completely full the water overflows into the larger tube, O, as shown by the arrows and is conducted to the pump vat by means of the drip pan. The mechanism secures continuous contact of the circulating water with the under side of plate B and at the same time permits rotation of B about a vertical axis.

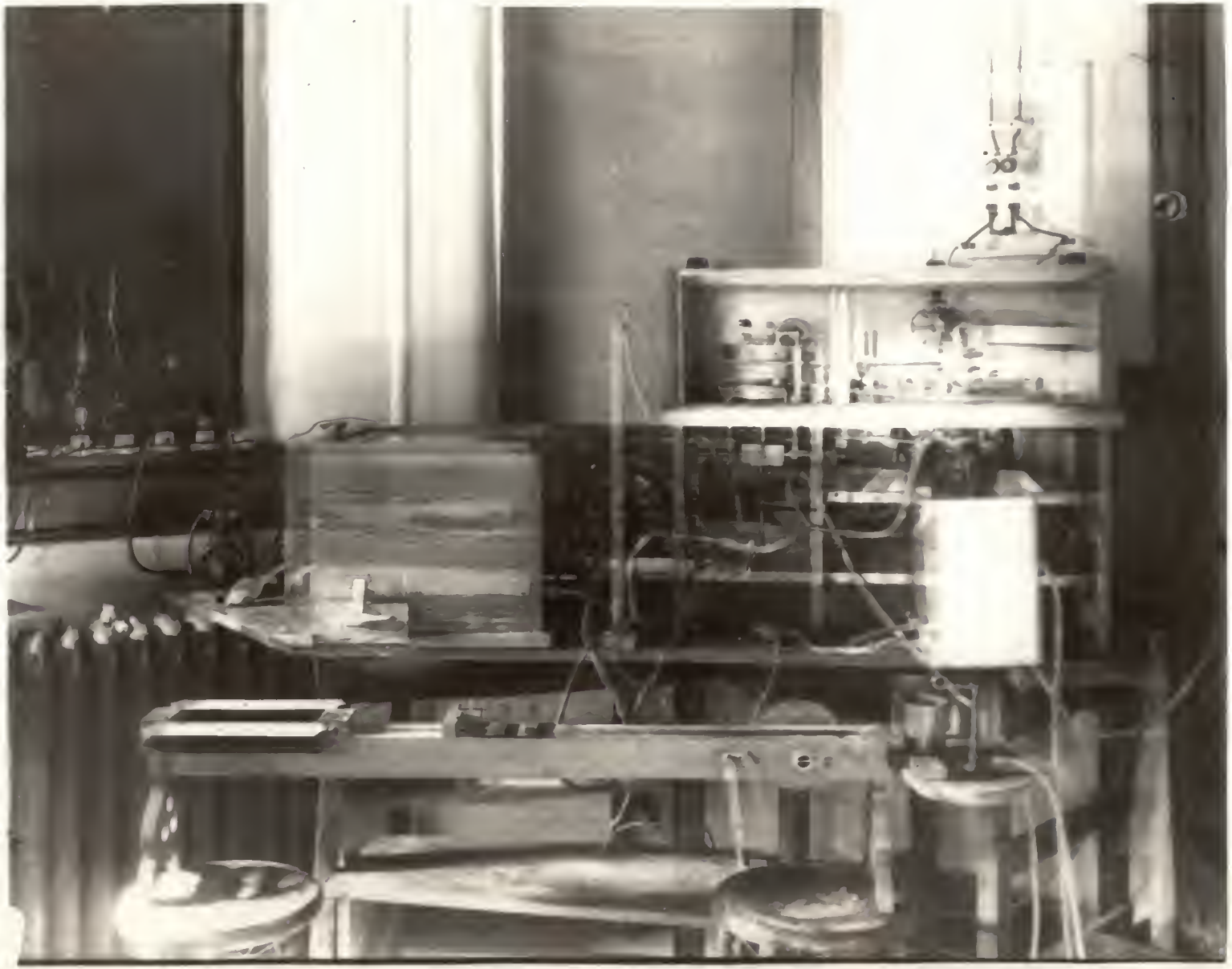

FIG. 1. Abrasion Machine Set up.

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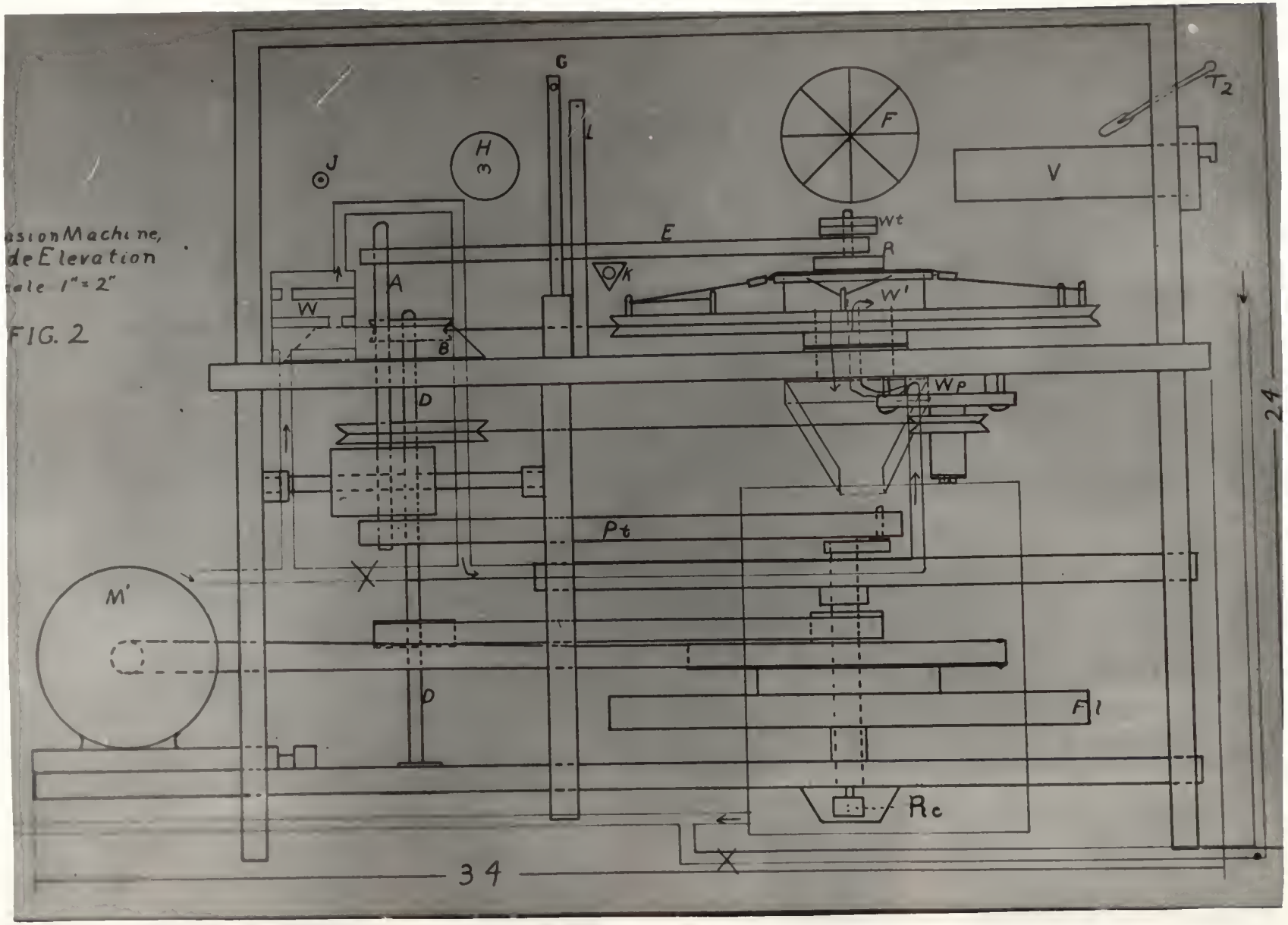
de Elevation
ale 1"=2"

FIG. 2



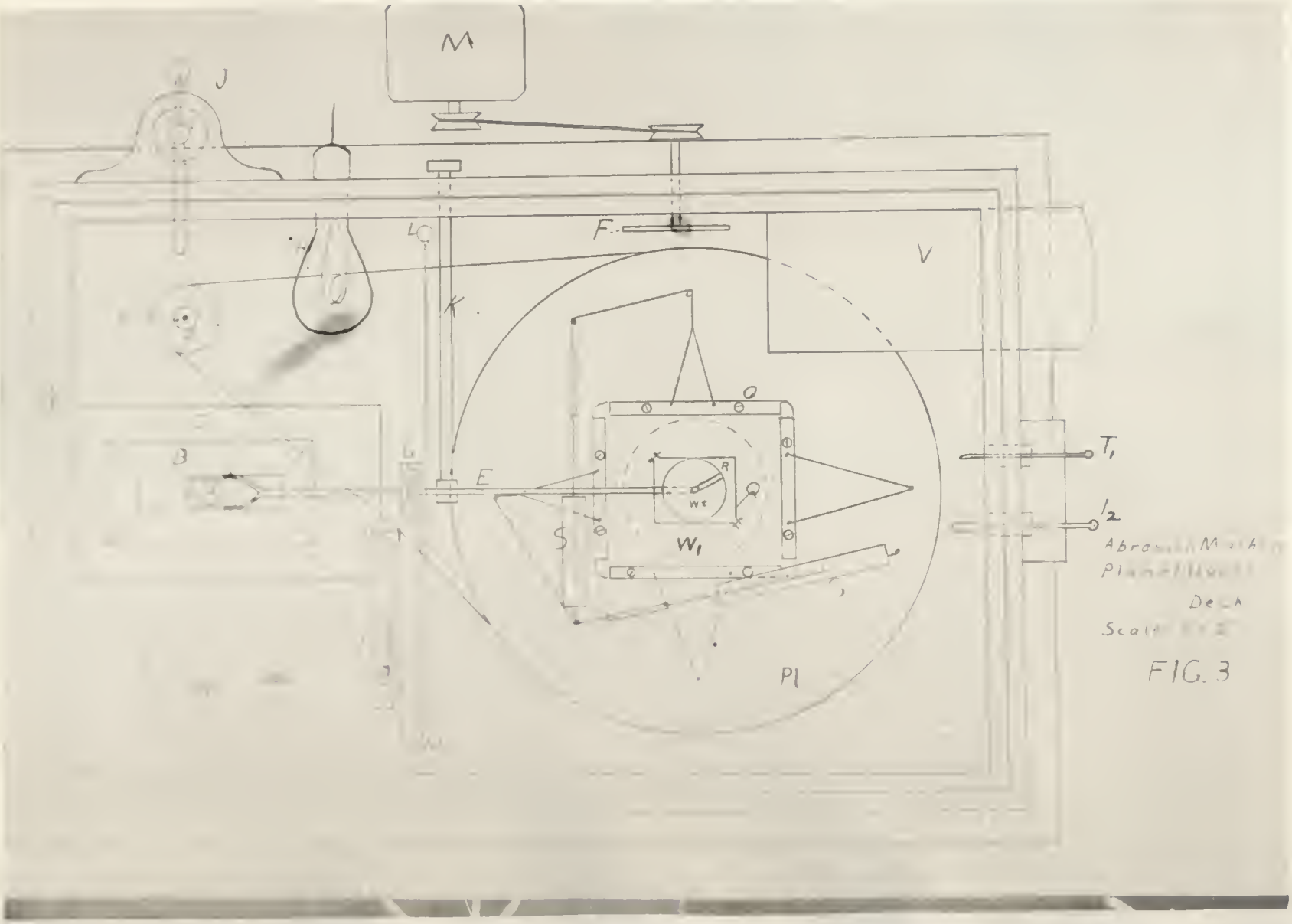
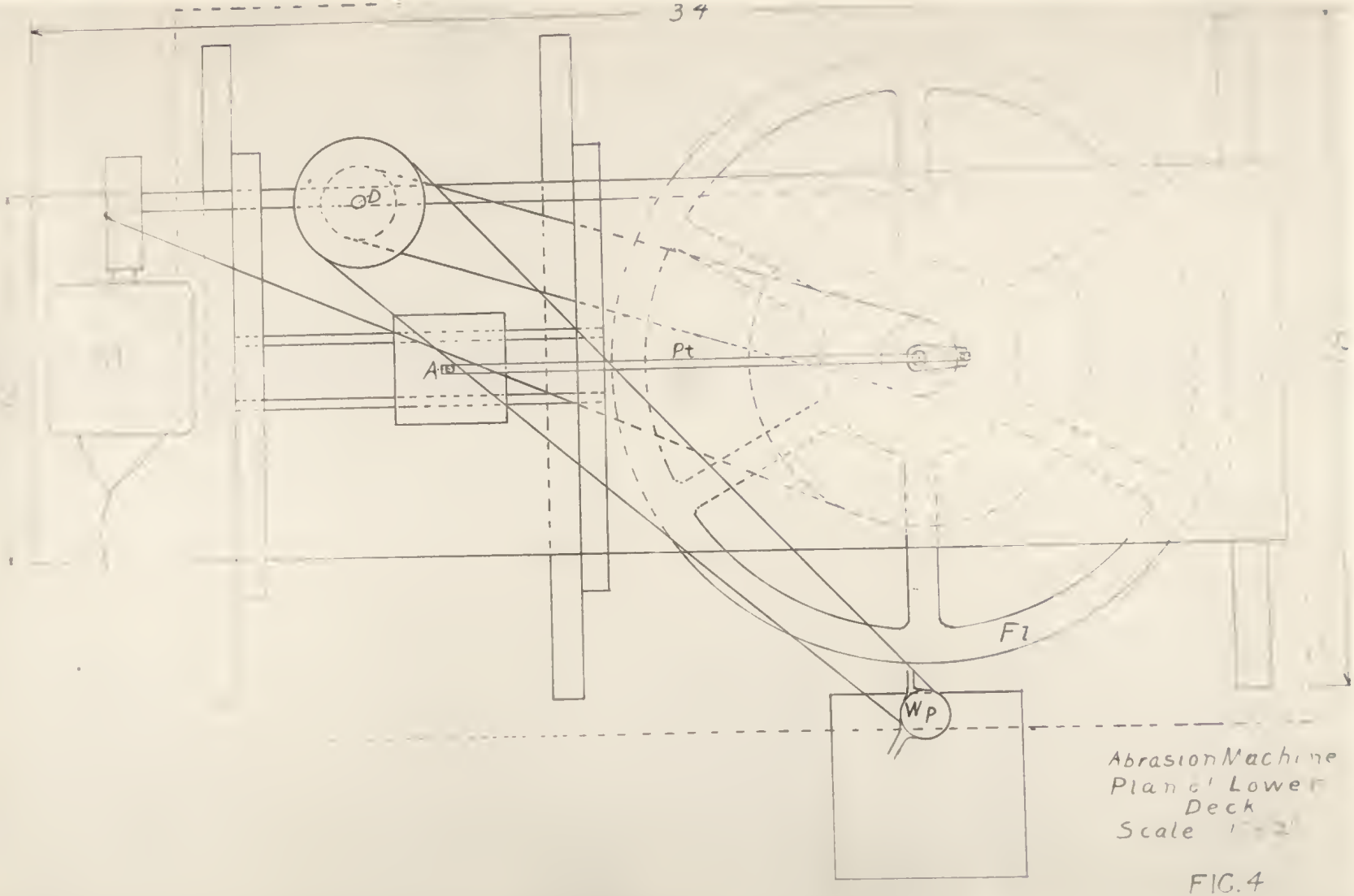
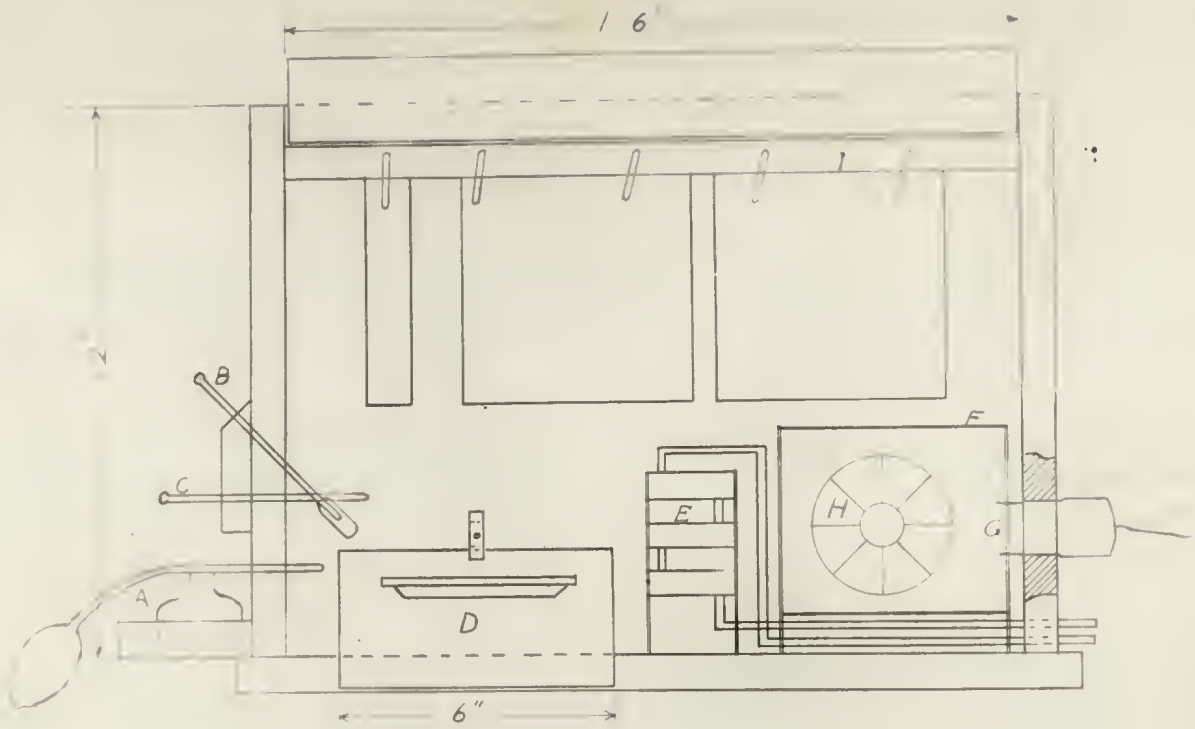


FIG. 3



Abrasion Machine
Plan of Lower
Deck
Scale 1" = 2'

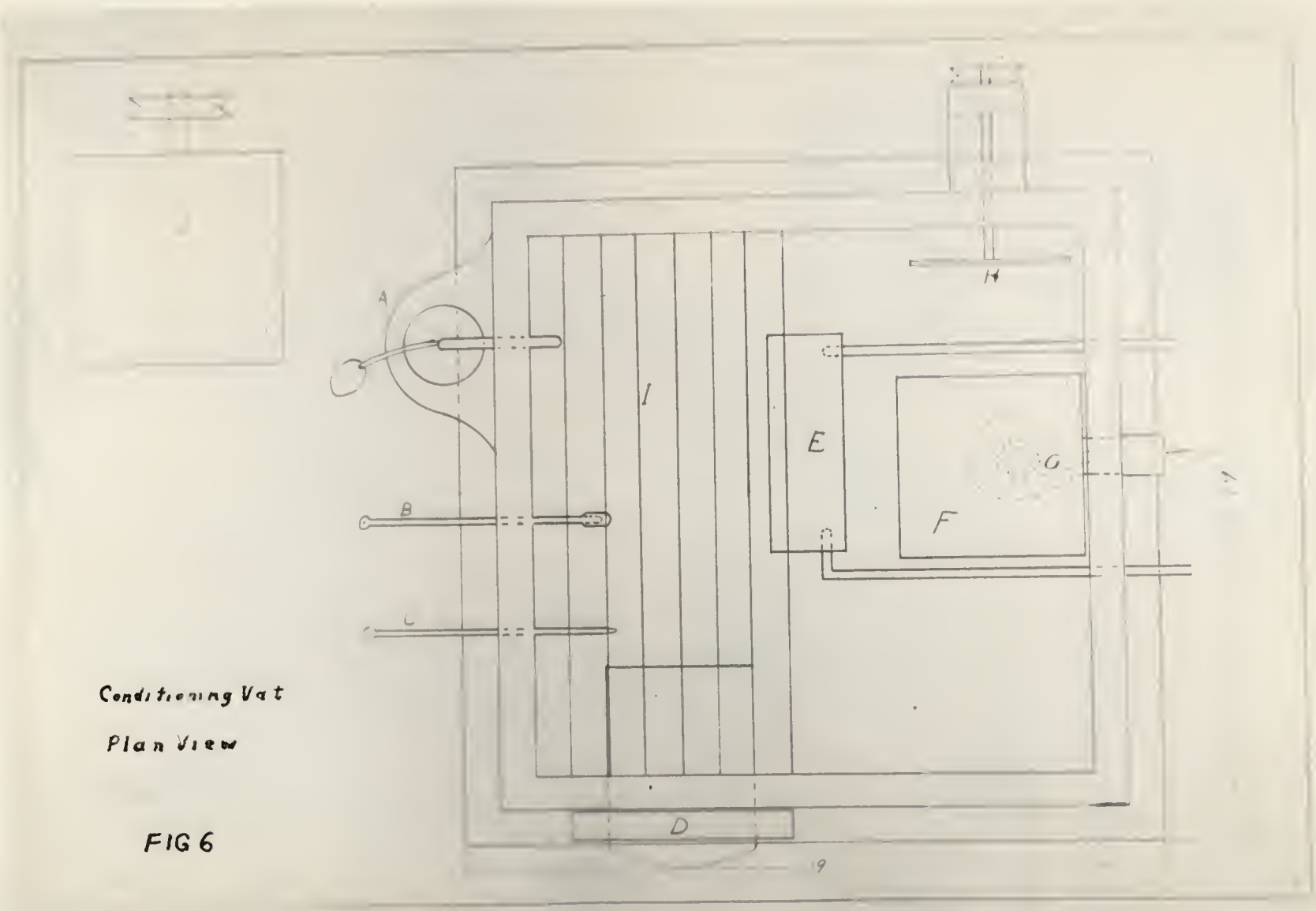
FIG. 4



Conditioning Vat
Side Elevation

Scale 1" = 2'

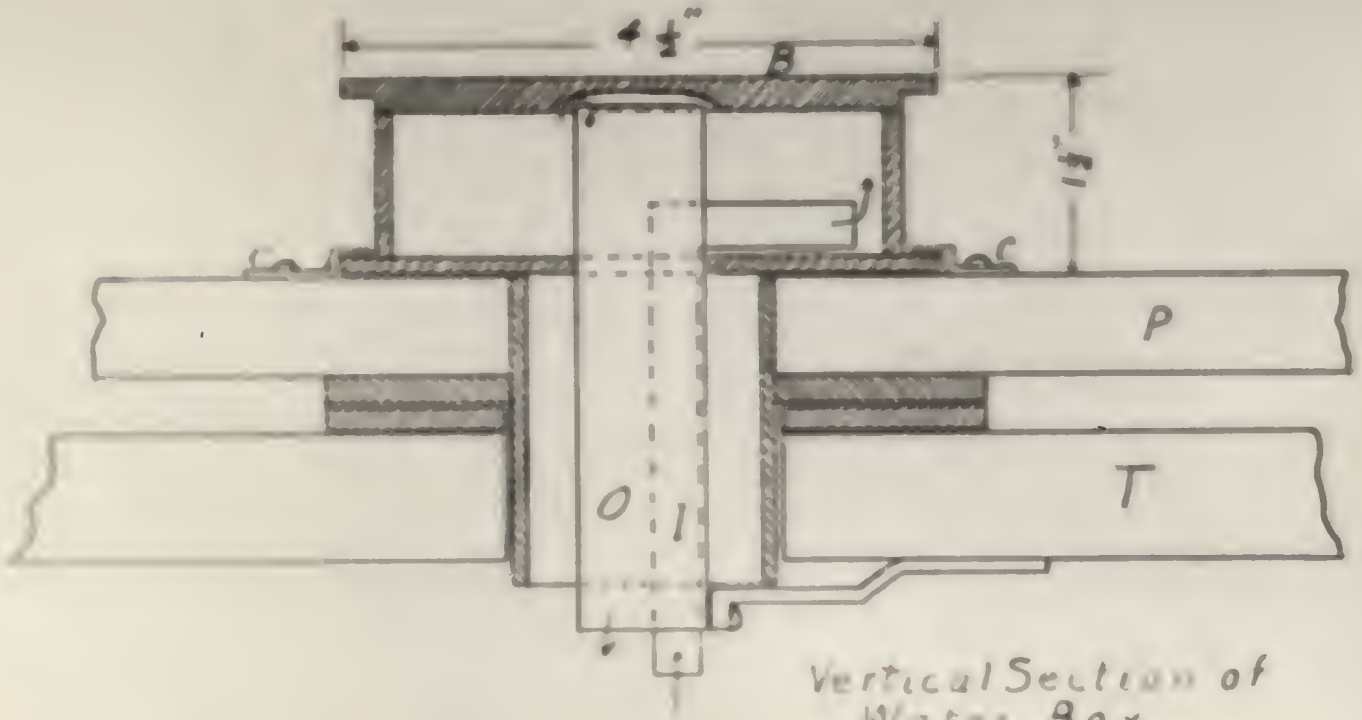
FIG. 5



Conditioning Vat

Plan View

FIG 6



Vertical Section of
Water Box
Scale - 1" - 1"

FIG. 7

MANIPULATION

Two samples are cut from the piece of cloth to be tested, which has been analyzed according to approved textile methods.* One 5" x 5" piece which is the necessary size to clamp in place on the revolving plate, Pl, and one 5" x 5" piece which is a control for the test. This control is taken from the same set of warp threads as will be used in the strip cut from the 5" x 5" piece. Another sample 2" x 2¼" is cut from analyzed serge which is used as the abradant.

All the samples are placed in the conditioning vat, Fig. 6, where they are kept under standard conditions for at least four hours. It was found impossible to maintain the conditions of temperature and relative humidity described by A. S. T. M.*, viz. 70° F. (21.1°C) and 65% relative humidity; therefore, throughout the experiment a temperature of 77°F (25°C) and relative humidity of 52% was used. The absolute humidity under the conditions last described is identical with that required for standard conditions.

The 5" x 5" piece of fabric is then clamped on the revolving plate, Pl, by means of the clamps, O, and the tension adjusted to 800 grams by turning the screws attached to

*American Society for Testing Materials.
Methods of Test for Textile Materials, by Committee D-13.

the balances, S.

The 2" x 2¼" piece of serge is clamped to the reciprocating rubbing block, R, and the movable arm, E, is adjusted in place on the upright shaft A. This adjusts the two surfaces so the block, R, will make a uniform stroke over the entire rubbing surface. The weights, Wt, are put in place to produce the desired pressure.

The box is then closed and the temperature and relative humidity are brought to standard conditions and reconditioned for twenty five minutes before the rubbing is started. Standard conditions are maintained throughout the period of rubbing, the temperature variation not exceeding 1°C and that of the relative humidity not to exceed 1%.

It was found by experiment that the serge, within a few thousand rubs, became so slick that only a negligible amount of wear on the fabric resulted. For this reason it was decided to perform twelve thousand rubs and at the end of which time, to replace the serge with new and to remove the fabric under test for a breaking strength test, provided the 12,000 point on the curve was desired. In case of the 24,000 point on the curve, the serge was renewed at 12,000 rubs while the fabric under test remained on the rubbing plate until 24,000 rubs had been accomplished. In a similar manner points for 36,000, 48,000, etc. were obtained.

At the end of the period of rub, as read from the revolution counter Rc, the pieces are removed and a piece 1¼" wide cut from the center of the worn part of the 5" x 5" *sample. This is raveled down to one inch wide and tested on breaking strength machine. Then the control is broken.

From data obtained in this manner, curves are plotted as mentioned above.

COMPUTATION OF A SAMPLE SET OF DATA

The purpose of breaking a control with each strip of worn material is to determine, as near as possible, the breaking strength of the sample had it not been worn.

As a standard for unrubbed fabrics a mean of all the controls used in any given curve is taken.

Then the breaking strength of each worn piece of fabric is corrected to this standard as is shown in the sample set of data taken. (See Table I.)

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*Figs. 8, 9, 10 are photograps showing the appearance of the worn section from which the 1¼" sample is cut.

Fig. 8. Crepe de chine Worn Sample.

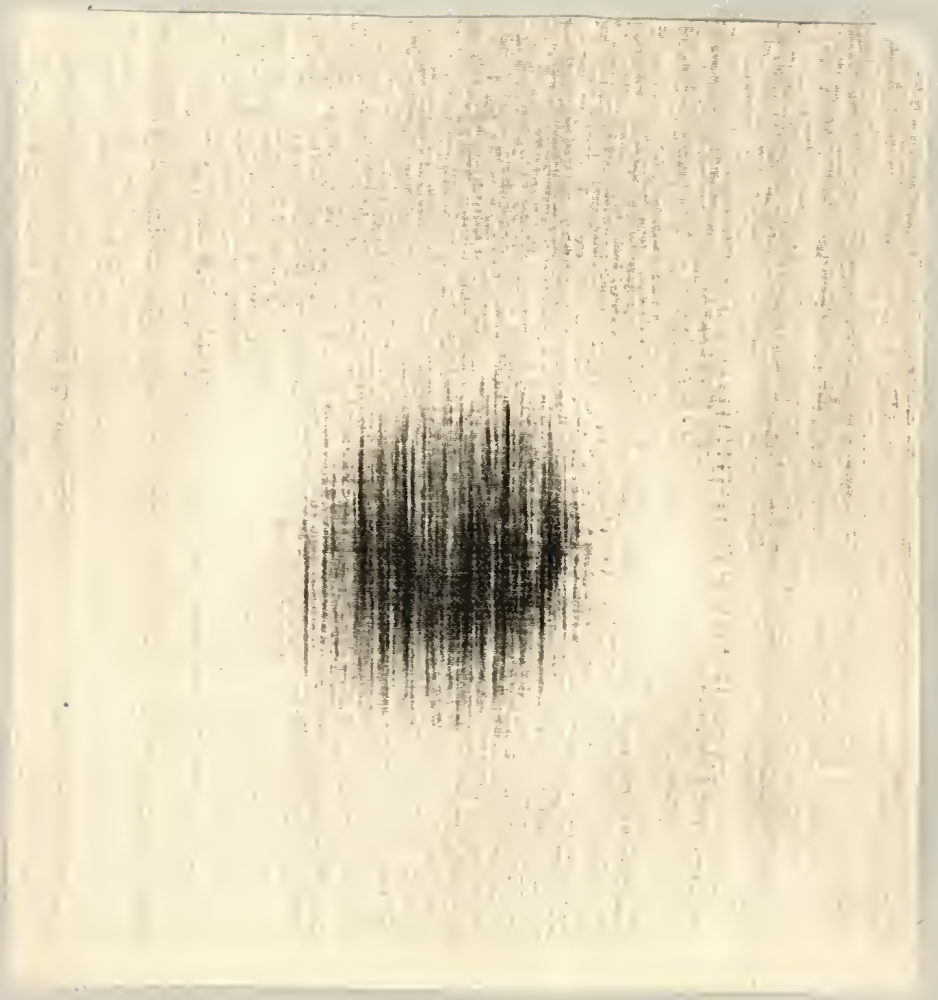

Fig. 9. Satin crepe Worn Sample.

Fig. 10. Rayon Worn Sample.

Table I

Sample Set of Data

Rayon, curve 3, warp. May 6 - 8

Test 1 24,000 rubs Box 25°C; 52% R.H.

Revolution counter Room 52% R.H.

beginning	18,800	27,900
end	6,000	6,000
	24,800	33,900

Breaking strength of worn sample 18.9 lbs.

" " " control " 20.0 lbs.

Test 2 48,000 rubs Box 25°C; 52% R.H.

Revolution counter Room 52% R.H.

beginning	40,410	53,250
end	6,000	6,000
	46,410	59,250
beginning	70,700	78,950
end	6,000	6,000
	76,700	84,950

Breaking strength of worn sample 14.9 lbs.

" " " control " 19.2 lbs.

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Table I Cont'd.

Test 3 72,000 rubs Box 25°C; 52% R.H.

Revolution counter		Room 52% R.H.	
beginning	88,000	900	16,550
end	6,000	6,000	6,000
	94,000	6,900	22,550
beginning	27,050	36,750	45,950
	6,000	6,000	6,000
	33,050	42,750	51,950

Breaking strength of worn sample 9.9 lbs.

" " " control " 17.6 lbs.

Controls averaged

20.0

19.2

17.6

3/ 56.8

18.9 average unrubbed breaking strength

Corrected points for curves

$\frac{18.9}{20}$ of 18.9 = 17.6 lbs. (Test 1)

$\frac{14.9}{19.2}$ of 18.9 = 14.66 lbs. (Test 2)

$\frac{9.9}{17.6}$ of 18.9 = 10.63 lbs. (Test 3)

TABULATION OF DATA AND CURVES

A complete fabric analysis of the Crepe de chine, Satin crepe, Rayon and the serge is given in Table II.

The method of recording and computing data, which is shown in Table I is used with all samples abraded. From this data Table III is compiled, and the curves (Figs. 11-18 inclusive) drawn for each set of data.

Tables IV, V and VI show the interpretation of these curves on the basis of breaking strength, and on the basis of number of rubs.

Table II

Analysis	Crepe de chine	Satin crepe	Rayon	Serge
Fabric				
Fiber used				
warp	silk	silk	cotton	wool
filling	silk	silk	rayon	wool
Width	39 in.	40 in.	34 in.	54 in.
Price per yard	$2.45	$3.95	55¢	$2.25
Weave	plain	satin	plain	twill
Color	gray	gray	tan	navy blue
Weight per sq.yd.	2.365 oz.	3.207 oz.	1.7111 oz	4.197 oz.
Breaking strength				
warp	41.58 lb.	67.5 lb.	19.8 lb.	19.5 lb.
filling	19.8 lb.	32.12 lb.	17.69 lb.	16.0 lb.

Cont'd on next page

Table II Cont'd.

Yarn				
Fiber				
warp	silk	silk	cotton	wool
filling	silk	silk	rayon	wool
Number per inch				
warp	117	150	65	67
filling	92	120	47	56
Breaking strength				
warp	.18 lb.	.34 lb.	.23 lb.	.25 lb.
filling	.18 lb.	.22 lb.	.34 lb.	.26 lb.
Twist per inch				
warp	none	none	22	12.0
filling	74	61.6	none	12.5
Ply				
warp	single	single	single	single
filling	?	?	single	single
Yarn size				
warp	98 den.	89 den.	80	33
filling	109 den.	82 den.	92 den.	29
Fiber				
Number in yarn				
warp	31	47	70	41
filling	27	44	20	37
Length				
warp	full	full	3/4 in.	2.75 in.
filling	full	full	full	1.125 in.

Table III

Name of Fabric	Curve and Point No.		Number of rubs	Actual Breaking Strength lbs.	Corrected Breaking Strength lbs.	Average Breaking Strength of Control
Crepe de chine	I	1	12,000	44.0	39.37	41.58
		2	24,000	39.2	40.49	41.58
		3	36,000	33.0	38.94	41.58
		4	48,000	25.1	23.32	41.58
		5	60,000	16.28	16.72	41.58
	II	1	18,000	34.32	38.0	39.6
		2	30,000	33.0	32.78	39.6
		3	42,000	33.0	32.34	39.6
		4	54,000	20.24	19.36	39.6
		5	66,000	13.64	13.64	39.6
	III	1	36,000	28.16	26.62	39.6
		2	48,000	26.4	26.4	39.6
		3	72,000	22.0	23.1	39.6
Satin Crepe	I	1	12,000	55.9	61.4	67.5
		2	24,000	42.7	47.2	67.5
		3	36,000	29.48	32.35	67.5
		4	48,000	5.72	6.16	67.5
	II	1	18,000	48.4	52.8	67.5
		2	30,000	22.44	24.64	67.5
	III	1	24,000	42.8	44.88	67.5
		2	36,000	24.0	26.4	67.5
		3	48,000	13.2	14.3	67.5
Rayon	I	1	24,000	19.59	19.59	19.59
		2	48,000	14.52	13.75	19.59
		3	72,000	7.04	7.48	19.59
	II	1	24,000	19.59	18.49	17.6
		2	48,000	14.95	17.37	17.6
		3	72,000	10.56	9.8	17.6
	III	1	24,000	18.9	17.6	18.9
		2	48,000	14.9	14.66	18.9
		3	72,000	9.9	10.63	18.9

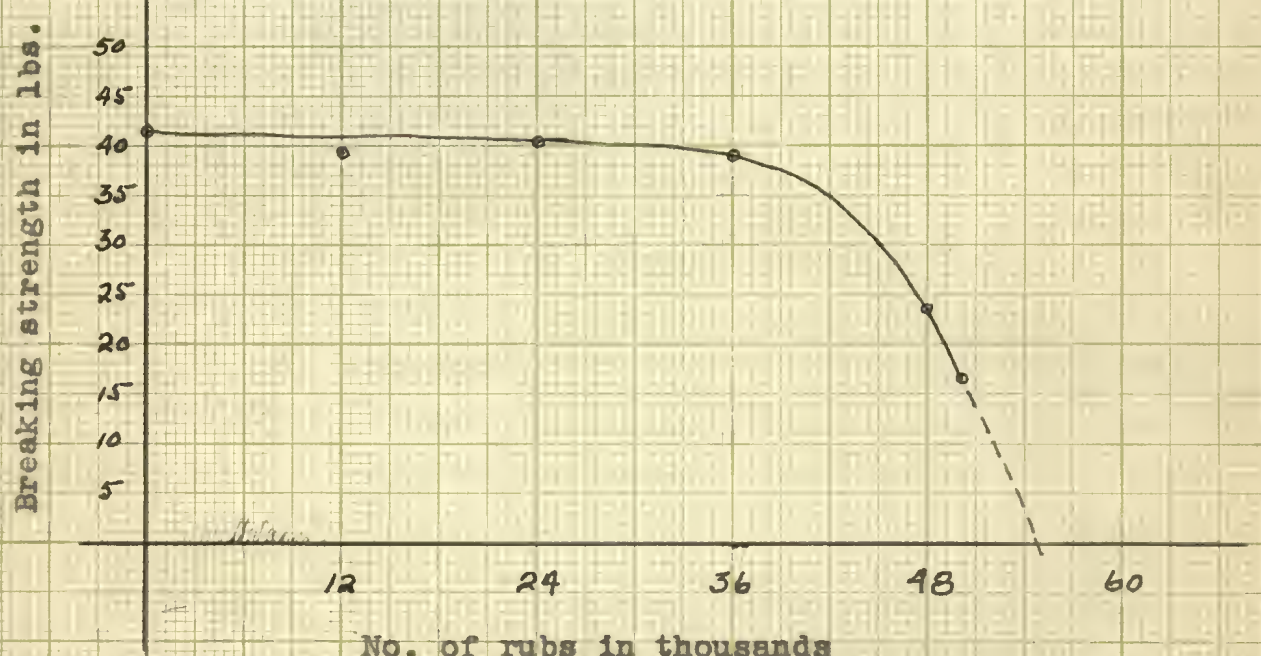

Fig. 11. Crepe de chine. Curve 1.

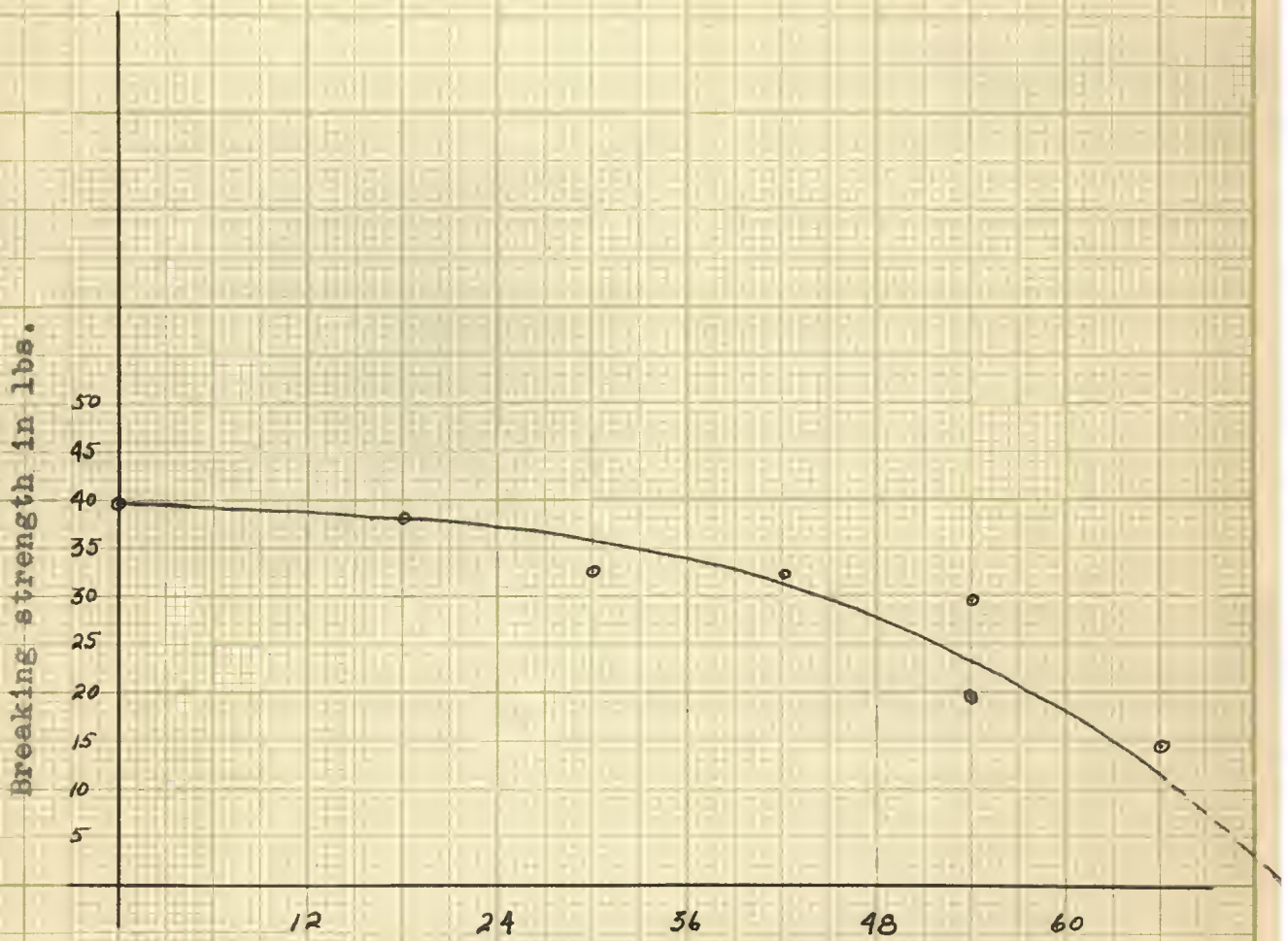

Fig. 12. Crepe de chine. Curve 2.

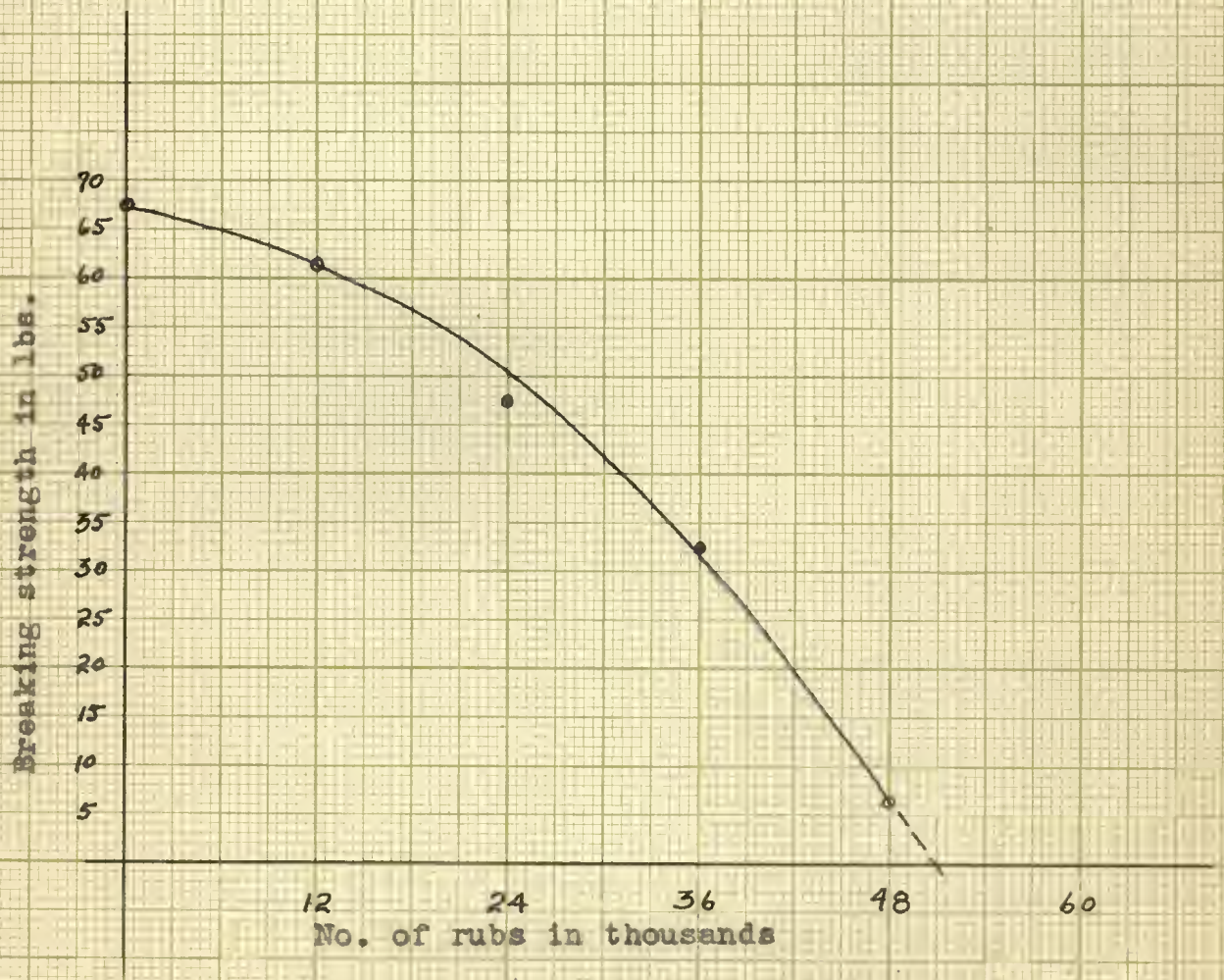

Fig. 13. Satin crepe. Curve 1.

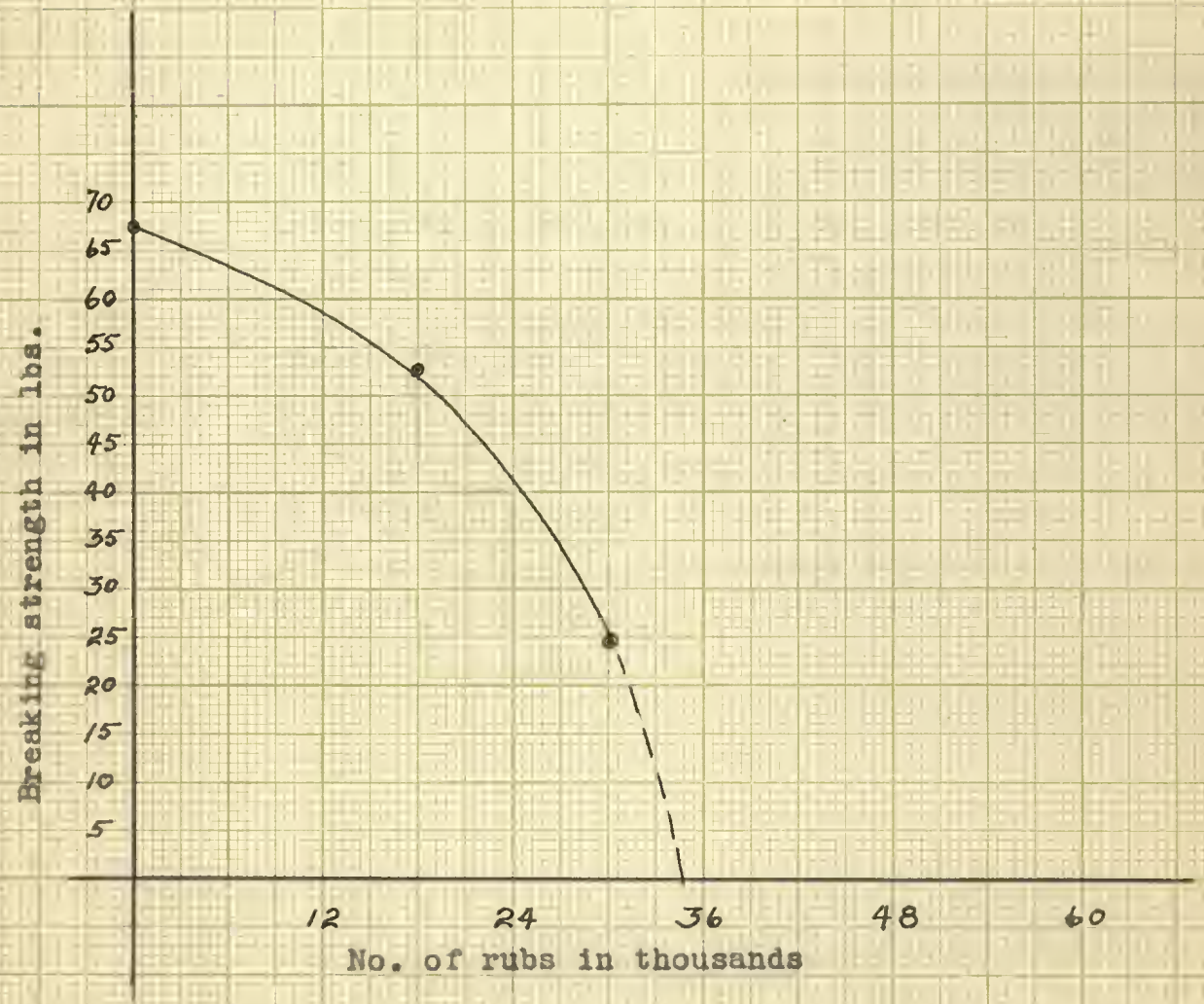

Fig. 14. Satin crepe. Curve 2.

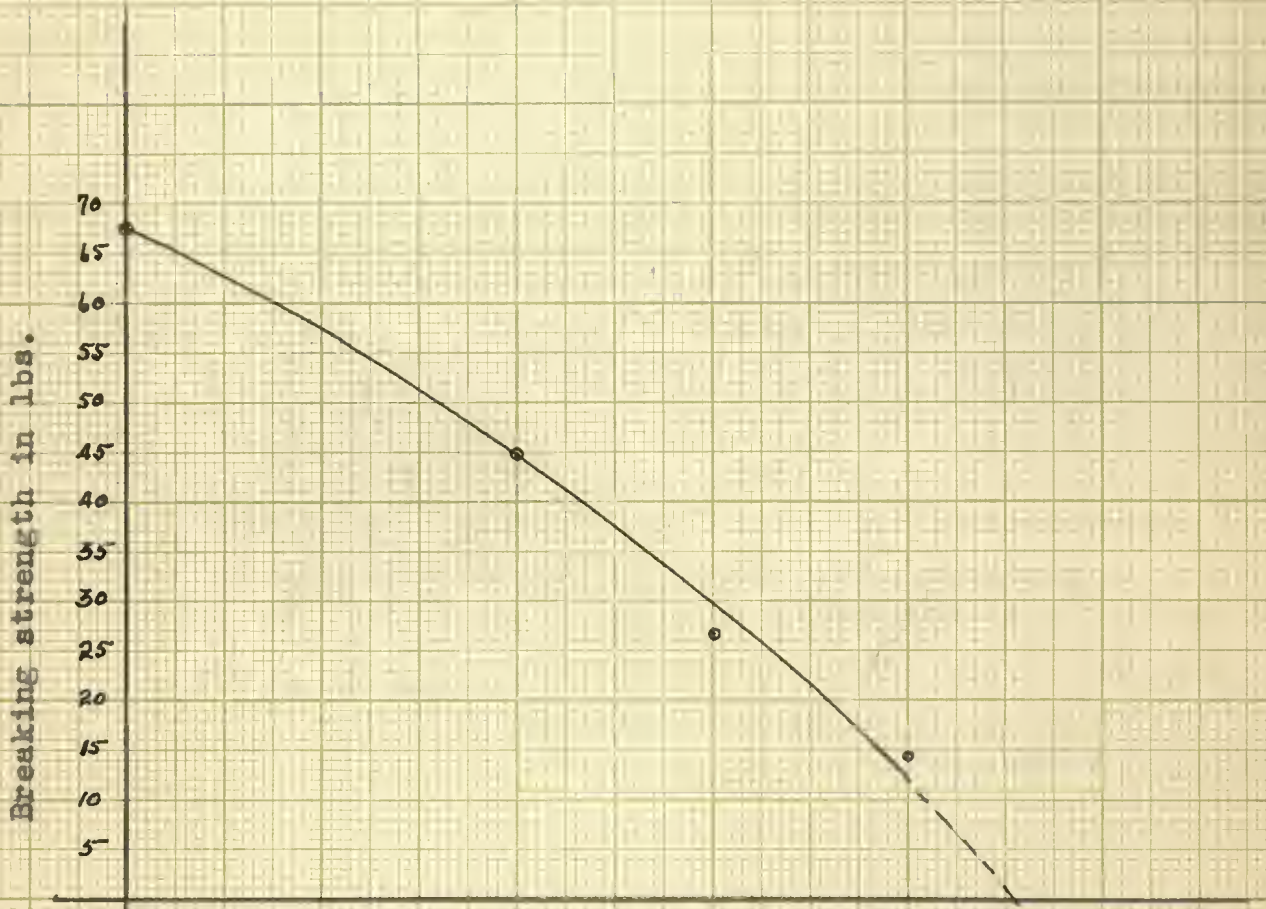

Fig. 15. Satin crepe. Curve 3.

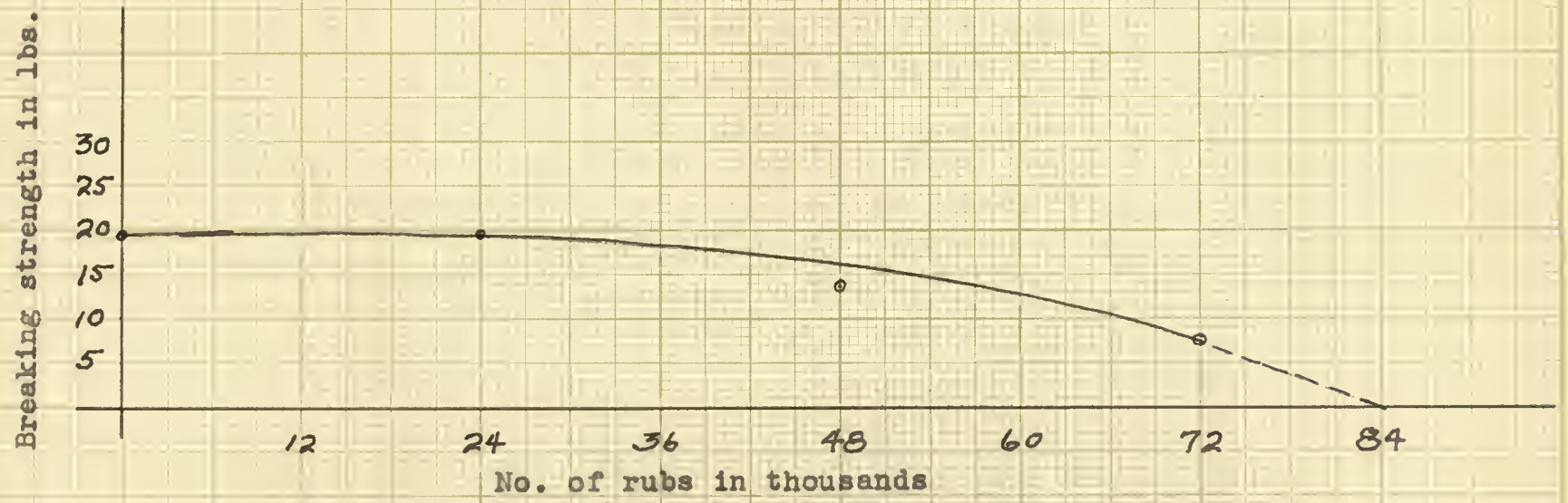

Fig. 16. Rayon. Curve 1.

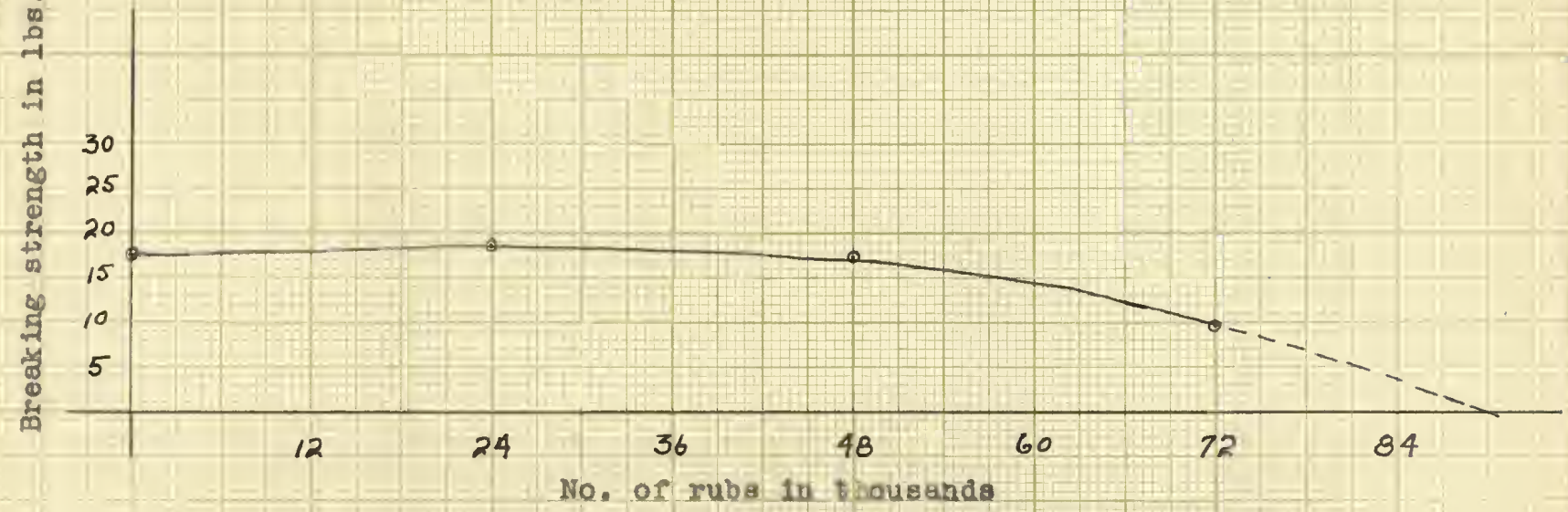

Fig. 17. Rayon. Curve 2.

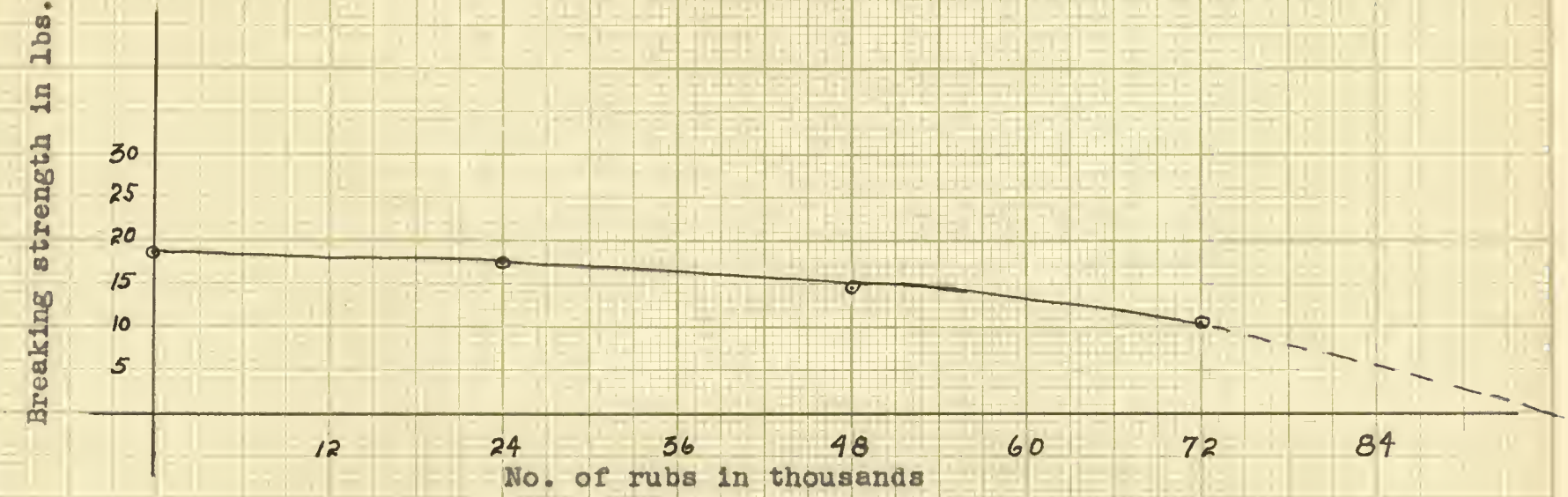

Fig. 18. Rayon. Curve 3.

Table IV

Crepe de chine, curve 1		
Basis of breaking strength		
Worn out at	54,500 rubs	
Half worn out at	49,000 rubs	
Basis of number of rubs		
Half worn out at	27,250 rubs	
% of original breaking strength at.	27,250 rubs	= 96.6 %
Crepe de chine, curve 2		
Basis of breaking strength		
Worn out at	74,000 rubs	
Half worn out at	58,000 rubs	
Basis of number of rubs		
Half worn out at	37,000 rubs	
% of original breaking strength at.	37,000 rubs	= 83.3 %
Crepe de chine, Mean values		
Basis of breaking strength		
Worn out at	64,250 rubs	
Half worn out at	53,500 rubs	
Basis of number of rubs		
Half worn out at	32,175 rubs	
Percentage average		89.99%

Table V

Satin Crepe, curve 1		
Basis of breaking strength		
Worn out at	51,000 rubs	
Half worn out at	35,000 rubs	
Basis of number of rubs		
Half worn out at	25,500 rubs	
% of original breaking strength at.	25,500 rubs	= 63.7%
Satin Crepe, curve 2		
Basis of breaking strength		
Worn out at	35,000 rubs	
Half worn out at	27,500 rubs	
Basis of number of rubs		
Half worn out at	17,500 rubs	
% of original breaking strength at.	17,500 rubs	= 79.2%
Satin Crepe, curve 3		
Basis of breaking strength		
Worn out at	54,000 rubs	
Half worn out at	33,000 rubs	
Basis of number of rubs		
Half worn out at	27,000 rubs	
% of original breaking strength at.	27,000 rubs	= 54.9%
Satin Crepe, Mean values		
Basis of breaking strength		
Worn out at	48,888 rubs	
Half worn out at	31,500 rubs	
Basis of number of rubs		
Half worn out at	25,250 rubs	
Percentage average		65.9%

Table VI

Rayon, Curve 1
Basis of breaking strength
Worn out at ..... 84,000 rubs
Half worn out at ..... 66,000 rubs

Basis of number of rubs
Half worn out at ..... 42,000 rubs
% of original breaking strength at. 42,000 rubs = 91.0%

Rayon, Curve 2
Basis of breaking strength
Worn out at ..... 89,000 rubs
Half worn out at ..... 73,000 rubs

Basis of number of rubs
Half worn out at ..... 44,500 rubs
% of original breaking strength at. 44,500 rubs = 99.5%

Rayon, Curve 3
Basis of breaking strength
Worn out at ..... 96,000 rubs
Half worn out at ..... 72,000 rubs

Basis of number of rubs
Half worn out at ..... 48,000 rubs
% of original breaking strength at. 48,000 rubs = 76.8%

Rayon, Mean values
Basis of breaking strength
Worn out at ..... 89,666 rubs
Half worn out at ..... 70,333 rubs

Basis of number of rubs
Half worn out at ..... 44,833 rubs
Percentage average 89.1%

SUMMARY OF RESULTS

On the basis of breaking strength of the unrubbed fabrics, satin crepe ranks highest, crepe de chine second and rayon third; but comparing the wearing life of the three, as shown by the number of rubs required to wear out the fabric, the order is reversed, viz., rayon longest, crepe de chine second and satin crepe third.

When satin crepe is half worn out on basis of number of rubs, it has 66% of its wear left in it; crepe de chine has 90% and rayon has 89%. Therefore, satin crepe is weakened from the beginning of wear much more than either of the other fabrics.

Comparing the length of time it requires to lower the breaking strength to half its original value, rayon is again found to rank first, crepe de chine second and satin crepe third.

The general shape of the curve of rayon is similar to that of crepe de chine, showing long wear at first and a more or less sudden decrease in strength when the fibers begin to weaken.

Figs. 8, 9, 10 show that as the wear progresses, the various fabrics react differently. Satin crepe shows consider-

able more wear since the long untwisted floats of the Satin weave are readily worn off. The untwisted warp of the Crepe de chine also goes through first, but the noticeable wear of the fabric is not so great as in Satin crepe. Rayon shows that wear is about equal on both cotton warp and rayon filling; both giving out at about the same time.

As a lining for a coat, one would expect to get by far the greater amount of wear from rayon or crepe de chine than from satin crepe.

These conclusions are drawn from data taken at constant temperature and constant relative humidity---therefore, the above comparisons hold for these conditions only; if any of the factors vary, undoubtedly the ratio of wear would change.

The apparatus used in the tests seems to be adequate for the purpose for which it was designed and constructed. Obviously any one of the factors influencing the wear of the fabric could be studied by holding the remaining factors constant.

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