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SPINNING TESTS OF COTTON COMPRESSED TO DIFFERENT DENSITIES.

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CONTENTS.

IN TIMES of prosperity, when transportation and storage facilities are taxed to the limit, the conservation and utilization of space in freight cars and terminal warehouses becomes of paramount importance. A considerable saving in space and freight charges would be possible if a more compact and neater package were adopted for cotton.

PURPOSE OF TESTS.

Does compressing cotton to higher densities than 15 pounds per cubic foot injure the spinning value of the cotton? This is a much discussed question among cotton growers, merchants, brokers, and manufacturers. The spinning tests herein described were conducted for the purpose of arriving at conclusions in regard to this question as definite as could be determined by tests covering a single season's growth.[1]

[1] These spinning tests were conducted under the general supervision of William R. Meadows, cotton technologist, and under the direction of William G. Blair, specialist in cotton testing, who was assisted by H. B Richardson, C. E. Folk, and E. S. Cummings, assistants in cotton testing. The Cleveland Big Boll was spun at the North Carolina State College of Agriculture and Engineering, Raleigh, N. C., and the other cottons were spun at the Clemson Agricultural College, Clemson College, S. C.

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KINDS OF BALES.

At present there are five distinct types of bales: Flat, standard or railroad compressed, high density, round, and ginner's compress. The first three are of frequent occurrence, while the latter two have varied in amount of use.

Flat bale.—Most of the cotton ginned in this country on saw gins is put up in the form of a rectangular package known as the flat bale. (Pl. 1, Fig. 1.) This bale has a density varying from 12 to 15 pounds per cubic foot. It is covered with all the different types and grades of burlap, has six ties or hoops, and varies in weight anywhere from 300 to 750 pounds.

Standard or railroad compressed bale.—The standard or railroad compressed bale (Pl. I, Fig. 2) is made by applying great pressure to the ordinary flat bale from which the ties have been removed and to which patches have been added to cover the cuts in the burlap where samples were drawn. Pressure is applied only to the top and bottom of the bale, thus allowing the cotton to spread slightly sidewise and endwise. This spreading and the speed with which the bales are handled make a very irregular package. A well-organized crew of press hands may compress as many as 120 bales per hour. The density of this type of bale is from 22 to 28 pounds per cubic foot and varies with the amount of cotton in the bale. The bale has usually eight ties when it leaves the compress.

High-density bale.—After the ties have been removed and patches added to cover the cuts in the burlap where samples were drawn, the flat bale is placed in the press, the side doors are raised, and steam pressure is applied to the bottom or movable platen. The cotton is compressed between the top and bottom platens. As the side doors prevent any side spreading of the bale, the cotton can spread only endwise. The addition of the side doors makes the high-density bale (Pl. II, Fig. 1) more uniform in shape than the standard bale with the same pressure. High-density bales are compressed at a much slower rate than are the standard density bales because of the use of the side-door attachment, the rate being about 70 bales per hour for the high-density compared with 120 bales per hour for the standard density.

It is an easy matter to detect the high-density bale because of its much more uniform shape and because of the nine ties fastened by a high-grade buckle. The high-density attachment is used when cotton is to be exported or shipped by water. The density of the bale is from 28 to 40 pounds per cubic foot, varying with the amount of cotton in the bale.

Round bale.—The round bale (Pl. II, Fig. 2) is made by taking the loose cotton from the gins and winding it in a continuous sheet around a core and at the same time applying pressure through other rolls, thus making a very compact cylindrical-shaped bale of small size. This bale averages about 250 pounds in weight, has no ties, and is usually covered with a higher grade of burlap than any other type of bale with the possible exception of the Egyptian bale. The density per cubic foot averages about 35 pounds. This bale does not have an extensive domestic distribution, but some foreign firms specify this type of bale when ordering cotton shipped from this country.

Ginners' compress bale.—A ginners' compress bale (Pl. III) is made in exactly the same manner as the flat bale only greater pressure is applied. The gin box and apparatus are made more rugged to withstand the greater pressure when compressing the loose cotton to this higher density. This type of bale usually has six ties. Its density varies from 25 to 30 pounds per cubic foot, depending upon the amount of cotton in the gin box.

This type of bale was not included in this study because of the small number of gin compresses in use and inability to secure a pure strain of cotton from such a compress.

CONDITIONS OF THE TESTS.

The general conditions of the tests follow, and specific information regarding details of results are found under the descriptions of the separate tests.

VARIETIES OF COTTON TESTED.

The varieties of cotton tested consisted of pure strains of Cleveland Big Boll, Rowden, Delta, and Webber 49 grown by men of reputation for their plant-breeding work.

The Cleveland Big Boll, Delta, and Webber 49 cottons were grown during the season of 1920 under normal weather conditions up to the time of picking. At this time, the rainfall delayed the opening of the bolls so that the number of pickings was reduced.

The climatic conditions during the season of 1921, under which the Rowden cotton was grown, were normal for the first half of the season followed by an extended drought which seemed to have the effect of shortening the length of staple.

All of the bales of the same variety of cotton were picked at the same time, ginned on the same day on the same battery of gins, and compressed on the same day with the exception of the round bale of the Rowden variety which was ginned on a different gin than the rectangular bales.

The reason for securing pure strains and proceeding as described, was to eliminate as many variables as possible with each variety, thus placing the variable of compression to different densities upon a strictly comparative basis. The test on each variety is therefore a separate test.

Detailed information regarding the cotton selected for the tests is shown below.[2]

Variety.	Grown at—	Season.	Grade.	Staple.	Stored in bale.
				Inches.	*Months.*
Cleveland Big Boll	Hartsville, S. C.	1920	Middling	$1\frac{1}{2}$	6
Rowden	Wills Point, Tex.	1921	Strict Middling	1	6
Delta	Scott, Miss.	1920	Middling	$1\frac{1}{8}$	12
Webber 49	Hartsville, S. C.	1920	Middling	$1\frac{1}{4}$	9

[2] The cotton was classed by members of the board of examiners, a committee authorized to class cotton at the future exchanges under the provisions of the United States cotton futures act.

WASTE DETERMINATIONS.

Accurate weighings were made of the net amount of cotton fed to and delivered by each cleaning machine and of the net amount of waste discarded by each. From these weighings, the percentage of visible, invisible, and total waste was determined. The percentage of waste for each variety is in the description of each test.

MECHANICAL CONDITIONS.

The cotton from the bales of different densities of the same variety was run under mechanical conditions which conformed to average mill conditions for the length of staple used. No changes were made except those necessary to maintain the desired weight or sizing of the stock in process.

MOISTURE CONDITIONS.

The moisture conditions under which the cotton is machined affect its spinning properties in a number of ways. The amount of invisible waste varies with the amount of moisture in the cotton as well as with differences in the character of the cotton. The moisture content depends upon the weather conditions to which the cotton has been exposed before reaching the mill and upon the relative humidity under which it is machined. Controlling the relative humidity in the mill tends to bring the cotton to a certain moisture level and thus reduces the varying factor of invisible waste caused largely by fluctuations in the moisture content of the cotton. Controlling the humidity also makes possible more accurate weighings or sizings and thus gives more even running work. The cotton also spins and weaves better under proper humidity conditions.

The humidifiers were regulated by hand as closely as possible to give a relative humidity of 50 per cent in the picker room, 60 per cent in the card room, and 70 per cent in the spinning room. At Raleigh, N. C., there were no humidifiers in the picker room, but as damp weather prevailed at the time the stock was on the pickers the humidity was above the desired amount at this point. There was no way to dehumidify in any of the tests. On excessively moist or dry days, it was not always possible to maintain the humidity conditions at the desired level. The actual conditions which prevailed are given under each test.

Samples of the raw stock from the bale, finisher picker lap, card sliver, final processes of drawing and roving, and yarn were collected for moisture determinations. The results are included under each test.

BREAKING STRENGTH AND SIZING OF THE YARN.

The yarns were tested for strength and size in the cotton testing laboratory at Washington, which is equipped with a modern automatic humidity and temperature regulating system which controls the humidity at 65 per cent and prevents the temperature from falling below 70° F.

Twenty-four skeins of 120 yards from each number and twist of yarn were reeled and placed on a specially constructed rack and allowed to condition at least 24 hours under 65 per cent relative humidity before breaking and sizing. Each skein was then broken and sized in rotation. This method assures breaking and sizing the yarn of the different lots under identical moisture conditions.

FIG. 1.—FLAT OR UNCOMPRESSED BALE, TOP, SIDE, AND END VIEWS. DENSITY, 12 TO 15 POUNDS PER CUBIC FOOT. APPROXIMATE DIMENSIONS, 54 BY 27 BY 48 INCHES.

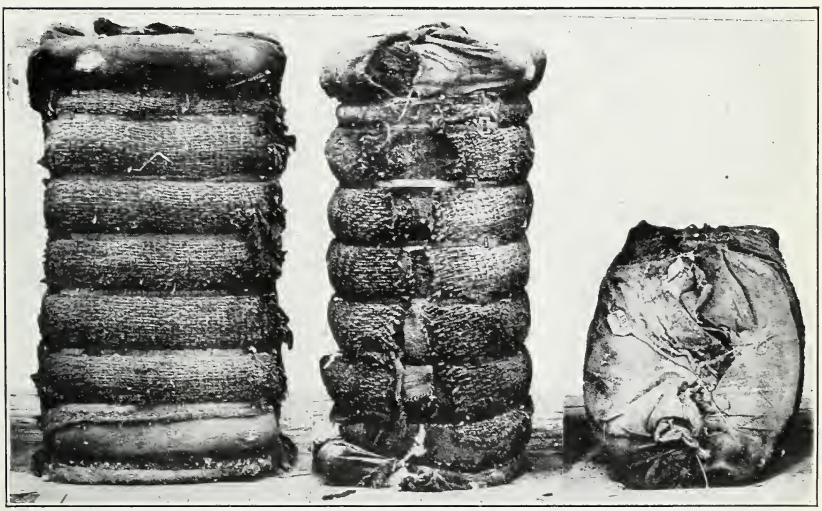

FIG. 2.—STANDARD OR RAILROAD COMPRESSED BALE, SHOWING TOP, SIDE, AND END VIEWS. DENSITY, 22 TO 28 POUNDS PER CUBIC FOOT. APPROXIMATE DIMENSIONS, 56 BY 28 BY 18 INCHES.

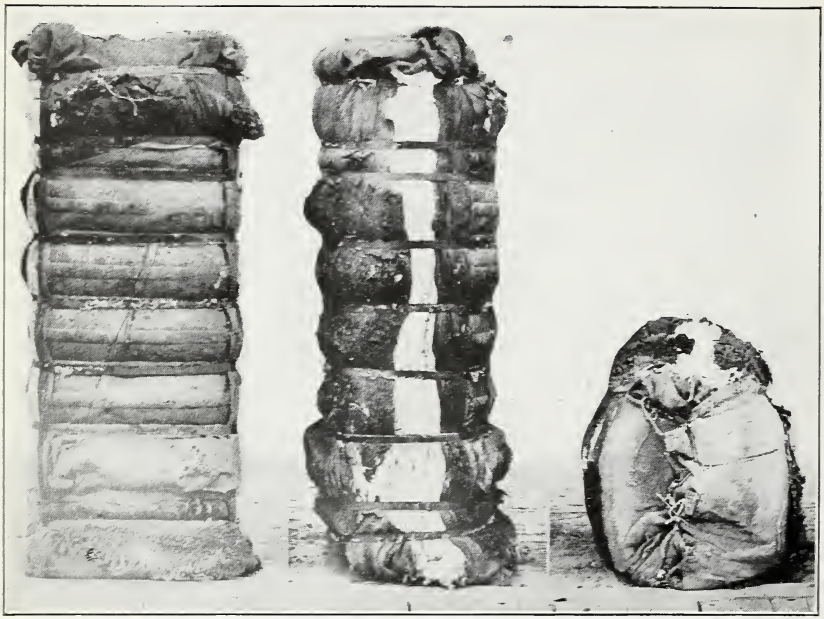

FIG. 1.—HIGH-DENSITY BALE, TOP, SIDE, AND END VIEWS. DENSITY, 28 TO 40 POUNDS PER CUBIC FOOT. APPROXIMATE DIMENSIONS, 59 BY 24 BY 19 INCHES.

FIG. 2.—ROUND BALE, SIDE AND END VIEWS. DENSITY, 28 POUNDS PER CUBIC FOOT. APPROXIMATE DIMENSIONS, 35 BY 20 INCHES (DIAMETER).

GINNER'S COMPRESS BALE, SHOWING TOP AND SIDE OF BALE. DENSITY, 25 TO 35 POUNDS PER CUBIC FOOT. APPROXIMATE DIMENSIONS, 52 BY 25 BY 20 INCHES.

IRREGULARITY OF YARNS.

The irregularity or the quality of the yarns was determined by three methods: By photographing the yarn, testing for evenness on a Moscrop single strand tester, and calculating the average deviation of the sizings and strengths obtained in the skein-breaking strength tests.

SPINNING TESTS OF CLEVELAND BIG BOLL COTTON OF FIFTEEN-SIXTEENTHS-INCH STAPLE.

The Cleveland Big Boll cotton was compressed into four bales: A flat bale, a standard or railroad compressed bale, a high-density bale, and a high-density bale compressed while wet. The latter bale was made by wetting a flat bale with water from a hose for a day and then compressing it to high density in the usual manner.

PERCENTAGE OF WASTE.

Table 1 gives the percentage of visible, invisible, and total waste obtained from the different types of bales.

TABLE 1.—*Percentage of waste from Cleveland Big Boll cotton of fifteen-sixteenths-inch staple; grade, Middling.*

Type of bale	Flat.	Standard.	High density.	High density wet.
PICKER WASTE.[1]	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Opener-breaker motes and fly	0.96	1.20	0.98	1.50
Finisher motes and fly	.43	.52	.45	.66
Total visible	1.39	1.72	1.43	2.16
Invisible	.94	1.02	.96	1.46
Total visible and invisible	2.33	2.74	2.39	3.62
CARD WASTE.[2]				
Flat strips	2.59	3.00	2.69	3.17
Cylinder and doffer strips	.70	.83	.69	.88
Motes and fly	1.53	1.65	1.19	2.17
Sweepings	.10	.11	.09	.12
Total visible	4.92	5.59	4.66	6.34
Invisible	[3].37	.09	.15	.62
Total visible and invisible	4.55	5.68	4.81	6.96
PICKERS AND CARDS.[1]				
Total visible	6.20	7.16	5.98	8.27
Total invisible	.58	1.11	1.11	2.06
Total visible and invisible	6.78	8.27	7.09	10.33

[1] Based upon net weight fed to bale-breaker.
[2] Based upon net weight fed to cards.
[3] Gain.

Referring to Table 1 and comparing the percentages of visible waste obtained from the different types of bales, it is seen that the flat bale and the high-density bale were practically equal in wastefulness. The standard or railroad compressed bale was about 1 per cent more wasty than either the flat or high-density bale, while the high-density bale compressed while wet was about 2 per cent more wasty.

The percentages of visible waste obtained from the bales of different compressions were:

	Per cent.
Flat bale	6.20
Standard or railroad compressed bale	7.16
High-density bale	5.98
High-density bale compressed wet	8.27

MOISTURE CONDITIONS.

Table 2 gives the average temperatures and relative humidities under which each type of bale was tested.

TABLE 2.—*Average temperatures and relative humidities during the testing of Cleveland Big Boll cotton of fifteen-sixteenths-inch staple.*

Type of bale	Flat.		Standard.		High density.		High density wet.	
	Temperature.	Relative humidity.	Temperature.	Relative humidity.	Temperature.	Relative humidity.	Temperature.	Relative humidity.
STAGE.	° F.	Per cent.	° F.	Per cent.	° F.	Per cent.	° F.	Per cent.
When opened	91	57	85	66	83	62	82	57
Finisher picker	93	57	89	59	84	56	92	56
Card	85	58	87	58	90	55	90	55
Drawing frames:								
59 grain sliver	83	61	85	62	89	57	90	56
73 grain sliver	87	58	83	62	87	60	87	56
Roving frames:								
2.00 hank intermediate	87	58	87	58	89	57	88	57
4.40 hank fine	88	57	88	57	89	56	90	56
5.40 hank fine	87	57	88	56	89	55	89	55
Spinning frame:								
16's yarn	91	56	91	56	89	55	89	55
22's yarn	84	56	84	56	85	57	85	57

Table 3 gives the percentage of moisture regain of the cotton at the various stages of the manufacturing process.

TABLE 3.—*Percentage of moisture regain in the Cleveland Big Boll cotton at the different stages of the manufacturing process.*

Type of bale	Flat.	Standard.	High density.	High density wet.
STAGE OR SAMPLE.	Per cent.	Per cent.	Per cent.	Per cent.
From bale	6.04	7.12	7.12	6.95
Finisher picker lap	4.82	6.61	6.10	5.76
Finisher picker lap during carding	6.81	7.00	6.91	6.99
Card sliver	6.82	6.78	6.64	6.46
Finisher drawing:				
59 grain sliver	7.35	7.06	6.15	6.15
73 grain sliver	6.67	7.12	6.38	6.27
Roving frames:				
2.00 hank for 16's	6.61	6.55	6.27	6.27
4.40 hank for 22's	5.99	6.10	6.38	6.33
5.40 hank for 28's	7.00	6.84	6.95	6.89
Ring spinning frame:				
16's yarn	6.67	6.55	6.61	6.55
22's yarn	6.78	6.78	6.78	6.72
28's yarn	7.06	7.00	6.44	6.84

BREAKING STRENGTH OF YARNS.

The cotton of each compression was spun into 16's, 22's, and 28's yarn with twists equal to 4.25, 4.50, and 4.75 times the square root of the number spun. The average breaking strength of these yarns are shown in Table 4.

TABLE 4.—*Breaking strength in pounds per skein of 120 yards of yarn spun from Cleveland Big Boll cotton, fifteen-sixteenths-inch staple.*

No. of yarn.	New Draper standard.	Twist multiplier.	Type of bale.			
			Flat.	Standard.	High density.	High density wet.
	Pounds.		*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
16's	120	4.25	109.1	101.2	110.3	94.8
		4.50	107.0	102.4	107.5	92.0
		4.75	106.8	102.6	107.5	93.5
		Average..	107.6	102.1	108.4	93.4
22's	87	4.25	73.3	70.7	74.5	64.7
		4.50	73.0	70.9	74.3	65.7
		4.75	72.7	70.6	73.1	65.0
		Average..	73.0	70.7	74.0	65.1
28's	69	4.25	54.7	53.2	54.5	47.3
		4.50	53.1	52.7	54.1	48.0
		4.75	52.4	51.9	54.9	48.0
		Average..	53.4	52.6	54.5	47.8

Referring to Table 4 and comparing the breaking strength of the yarn spun from the cotton of the different types of bales, it is seen that there is practically no difference between the strength of the yarns obtained from the flat bale and the high-density bale compressed under normal conditions. The standard bale produced yarns slightly weaker than those produced from either the flat or high-density bale compressed under normal conditions, while the high-density bale compressed while wet produced yarns about 12 per cent weaker.

None of the yarns broke as strong as the new Draper standard. This weakness may have been due to the excessive rainfall, which delayed the opening of the bolls and the picking of the cotton.

IRREGULARITY OF YARNS.

The following figures give the irregularity of the sizings and breaking strengths of the yarns from the different types of bales:

	Sizing (per cent).	Break (per cent).
Flat bale	1.97	3.72
Standard or railroad compressed bale	1.98	4.30
High-density bale	2.17	4.02
High-density bale compressed wet	2.22	4.18

These figures indicate that there is practically no difference in the irregularity of the sizings or strengths of the yarns from the different types of bales.

The results of the calculations of the irregularity of the yarns are verified by tests on the Moscrop single-strand tester. Figure 1 is a photograph of a chart made by this tester when breaking 22's yarn spun from cotton compressed to different densities.

Each dot in Figure 1 represents the breaking strength of a single strand of yarn 12 inches long. The greater the distance these dots are from a horizontal line, the more irregular the yarn.

Plate IV, Figure 1, is from a photograph of 22's yarn spun from the Cleveland Big Boll cotton which shows practically no difference in the quality of the yarn spun from the different types of bales.

MANUFACTURING PROPERTIES.

There was no noticeable difference in the running of the different types of bales.

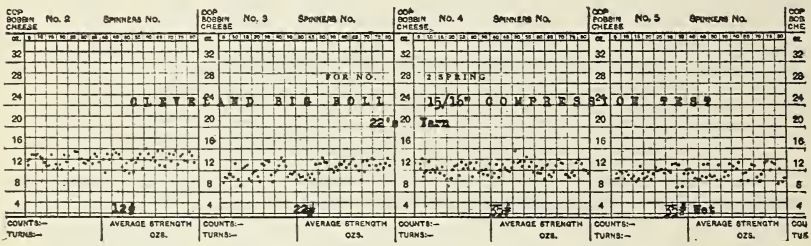

FIG. 1.—Irregularity of 22's yarn spun from Cleveland Big Boll cotton compressed to different densities.

SUMMARY OF TESTS.

The results of this test indicate that compressing cotton in a dry or normal condition does not injure its spinning value.

Compressing cotton to high density while wet increased the waste approximately 2 per cent, and it also caused a decrease in the breaking strength of the yarn of about 12 per cent.

SPINNING TESTS OF ROWDEN COTTON OF 1-INCH STAPLE.

The Rowden cotton was compressed into four types of bales: A flat bale, a standard or railroad compressed bale, a high-density bale, and a round bale.

PERCENTAGE OF WASTE.

Table 5 gives the percentage of visible, invisible, and total waste obtained from the different types of bales.

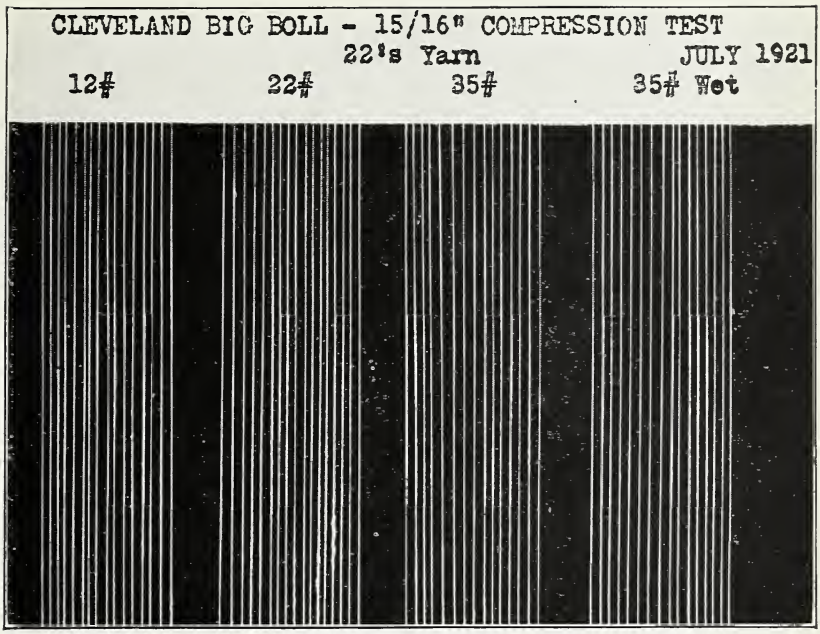

FIG. 1.—PHOTOGRAPH OF 22'S YARN SPUN FROM CLEVELAND BIG BOLL COTTON COMPRESSED TO DIFFERENT DENSITIES.

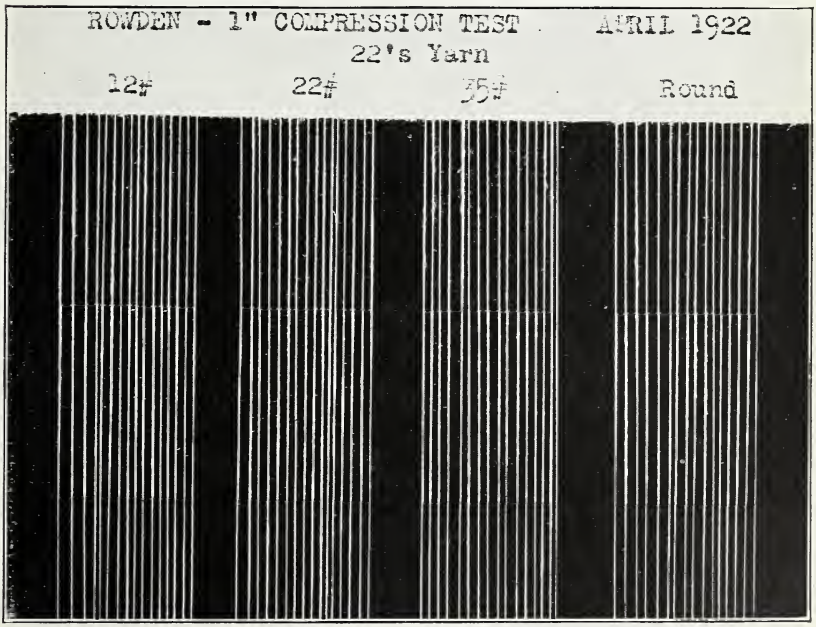

FIG. 2.—PHOTOGRAPH OF 22'S YARN SPUN FROM ROWDEN 1-INCH COTTON COMPRESSED TO DIFFERENT DENSITIES.

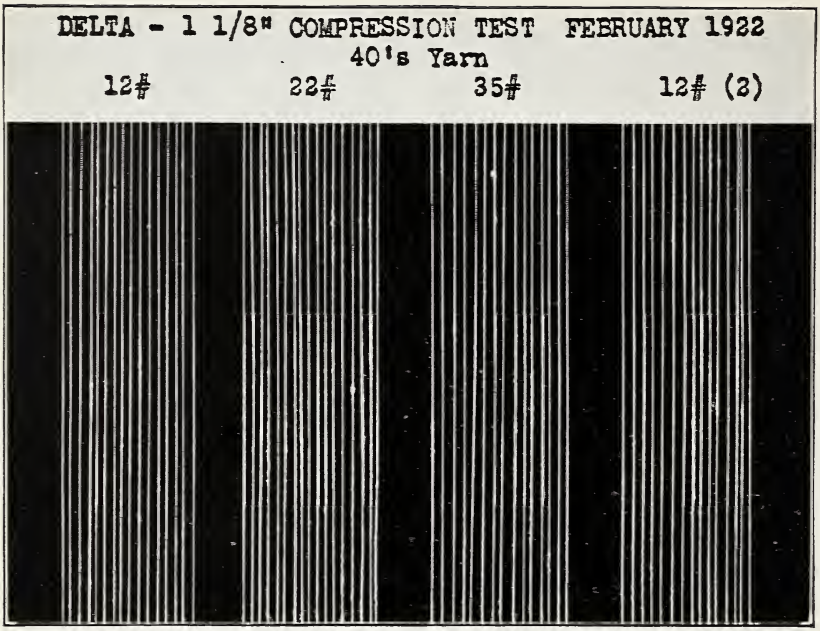

FIG. 1.—PHOTOGRAPH OF 40's YARN SPUN FROM DELTA 1⅛-INCH COTTON COMPRESSED TO DIFFERENT DENSITIES.

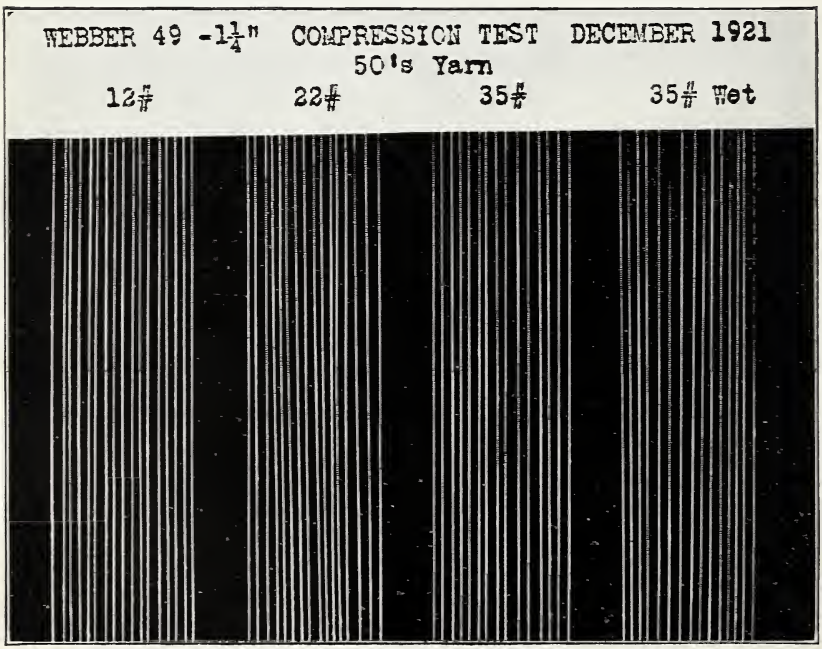

FIG. 2.—PHOTOGRAPH OF 50's YARN SPUN FROM WEBBER 49 COTTON COMPRESSED TO DIFFERENT DENSITIES.

TABLE 5.—*Percentage of waste from Rowden cotton of 1-inch staple; grade, Strict Middling.*

Type of bale	Flat.	Standard.	High density.	Round.
PICKER WASTE.[1]	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Opener-breaker motes and fly	0.95	0.77	0.76	0.68
Finisher motes and fly	.89	.78	.92	.81
Total visible	1.84	1.55	1.68	1.49
Invisible	.85	.46	.77	.14
Total visible and invisible	2.69	2.01	2.45	1.63
CARD WASTE.[2]				
Flat strips	1.85	1.78	1.68	1.76
Cylinder and doffer strips	.77	.81	.82	.79
Motes and fly	2.50	2.40	2.35	2.50
Sweepings	.14	.05	.05	.05
Total visible	5.26	5.04	4.90	5.10
Invisible	.13	[3].58	[3].10	[3].32
Total visible and invisible	5.39	4.46	4.80	4.78
PICKERS AND CARDS.[1]				
Total visible	6.96	6.49	6.46	6.51
Total invisible	.98	[3].11	.67	[3].17
Total visible and inviisble	7.94	6.38	7.13	6.34

[1] Based upon net weight fed to bale-breaker.
[2] Based upon net weight fed to cards.
[3] Gain.

Referring to Table 5 and comparing the percentages of waste obtained from the different types of bales, it is seen that there is practically no difference between the amount of visible waste discarded, the figures being:

	Per cent.
Flat bale	6.96
Standard or railroad compressed bale	6.49
High-density bale	6.46
Round bale	6.51

MOISTURE CONDITIONS.

Table 6 gives the average temperatures and relative humidities under which each type of bale was tested.

TABLE 6.—*Average temperatures and relative humidities during the testing of Rowden cotton of 1-inch staple.*

Type of bale	Flat.		Standard.		High density.		Round.	
	Temperature.	Relative humidity.	Temperature.	Relative humidity.	Temperature.	Relative humidity.	Temperature.	Relative humidity.
STAGE.	° F.	*Per cent.*	° F.	*Per cent.*	° F.	*Per cent.*	° F.	*Per cent.*
When opened	67	49	71	50	71	53	70	42
Finisher picker	76	51	73	54	72	41	74	61
Card	73	58	73	61	71	58	74	59
Drawing frames:								
53 grain sliver	72	58	73	60	72	59	75	59
73 grain sliver	74	59	74	61	72	60	74	58
Roving frames:								
4.00 hank fine	73	59	73	59	73	59	73	59
4.40 hank fine	73	59	73	59	73	59	73	60
5.60 hank fine	73	59	72	59	73	59	73	60
7.23 hank fine	73	60	73	59	73	60	73	60
Spinning frame:								
16's yarn	79	73	74	73	79	73	81	71
22's yarn	77	72	75	71	77	72	73	72
28's yarn	73	70	75	71	73	70	72	69
36's yarn	81	73	78	70	81	73	76	71

Table 7 gives the percentage of moisture regain of the cotton at the various stages of the manufacturing process.

TABLE 7.—*Percentage of moisture regain in the Rowden cotton at the different stages of the manufacturing process.*

Type of bale	Flat.	Standard.	High density.	Round.
STAGE OR SAMPLE.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
From bale	5.76	5.43	5.63	4.42
From bale-breaker	5.54	5.26	5.55	4.60
Finisher picker lap	5.57	5.65	5.26	5.26
Finisher picker lap during carding	5.19	5.57	4.90	5.50
Card sliver	5.32	5.57	4.95	5.82
53 grain finisher drawing	5.65	5.85	4.79	6.04
73 grain finisher drawing	5.82	5.87	5.45	5.79
Roving frames:				
4.00 hank, fine	5.76	5.81	5.09	5.54
4.40 hank, fine	6.10	6.10	6.43	6.38
5.60 hank, fine	6.43	6.49	6.49	5.76
7.23 hank, fine	5.93	6.15	5.09	6.10
Spinning frame:				
16's yarn	6.49	5.59	6.78	6.49
22's yarn	7.35	7.18	7.70	7.06
28's yarn	6.66	6.89	6.84	5.54
36's yarn	6.72	6.38	6.72	6.72

BREAKING STRENGTH OF YARNS.

The cotton of each compression was spun into 16's, 22's, 28's, and 36's yarn with twists equal to 4.25, 4.50, and 4.75 times the square root of the number spun. The average breaking strengths of these yarns are shown in Table 8.

TABLE 8.—*Breaking strength, in pounds, per skein of 120 yards of yarn spun from Rowden cotton, 1 inch staple.*

No. of yarn.	New Draper standard.	Twist multiplier.	Type of bale. Flat.	Standard.	High density.	Round.
	Pounds.		*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
16's	120	4.25	140.8	141.3	141.9	132.4
		4.50	133.8	142.8	137.7	131.1
		4.75	128.7	137.0	137.8	129.6
		Average	134.4	140.4	139.1	131.0
22's	87	4.25	92.0	99.4	94.9	87.3
		4.50	92.7	97.5	94.1	89.3
		4.75	89.9	94.9	95.7	87.3
		Average	91.5	97.3	94.9	88.0
28's	69	4.25	68.0	73.0	70.3	63.3
		4.50	67.4	72.9	71.3	64.4
		4.75	65.7	70.8	68.0	63.7
		Average	67.0	72.2	69.9	63.8
36's	54	4.25	48.3	51.0	50.6	44.2
		4.50	47.6	50.9	50.5	46.2
		4.75	47.0	50.7	49.5	45.7
		Average	47.6	50.9	50.2	45.4

Referring to Table 8 and comparing the breaking strength of the yarn spun from the cotton of the different types of bales, it is seen that the strongest results were obtained from the standard bale, followed in order by the high density bale, flat bale, and round bale.

All the 16's and 22's yarn broke stronger than the new Draper standard. All the 28's yarn, with the exception of that spun from the round bale, broke practically as strong as the standard strength for this number. The 36's yarn spun from all the types of bales was weaker than the standard strength for this number.

On an average, the yarns spun from the round bale were about 7 per cent weaker than the yarns spun from the other types.

IRREGULARITY OF YARNS.

The following figures give the irregularity of the sizings and breaking strengths of the yarns from the different types of bales:

	Sizing (per cent).	Break (per cent).
Flat bale	1. 98	4. 15
Standard or railroad compressed bale	1. 93	3. 87
High-density bale	1. 91	3. 97
Round bale	2. 22	4. 66

These figures indicate that there is practically no difference in the irregularity of the sizings or strengths of the yarn spun from the first three types of bales but the yarn from the round bale was slightly more uneven.

The results of the calculations of the irregularity of the yarns are verified by tests on the Moscrop single-strand tester. Figure 2 is a photograph of a chart made by this tester when breaking 22's yarn spun from the Rowden cotton compressed to different densities.

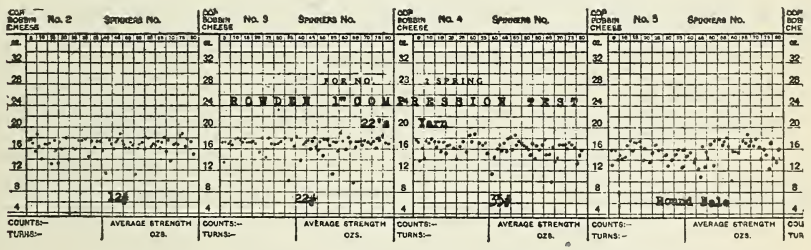

FIG. 2.—Irregularity of 22's yarn spun from Rowden 1" cotton compressed to different densities.

Each dot of figure 2 represents the breaking strength of a single strand of yarn 12 inches long. The greater the distance these dots are from a horizontal line, the more irregular the yarn.

Plate IV, Figure 2, is from a photograph of 22's yarn spun from the Rowden cotton which shows practically no difference in the quality of the yarn spun from the different types of bales.

MANUFACTURING PROPERTIES.

There was no noticeable difference in running the rectangular bales. A mill attempting to run round bales continuously must use special opening equipment.

SUMMARY OF TESTS.

The results of this test show that compressing cotton does not affect the amount of waste discarded in the manufacturing process. On an average, the yarn spun from the round bale was about 7 per cent weaker than that spun from the other types of bales.

SPINNING TESTS OF DELTA COTTON OF 1 1-8 INCH STAPLE.

The Delta cotton was compressed into three types of bales: A flat bale, a standard or railroad compressed bale, and a high-density bale.

PERCENTAGE OF WASTE.

Table 9 gives the percentage of visible, invisible, and total waste obtained from the different types of bales.

TABLE 9.—*Percentage of waste from Delta cotton of 1⅛ inch staple; grade, Middling.*

Type of bale	Flat.	Standard.	High density.
PICKER WASTE.[1]	*Per cent.*	*Per cent.*	*Per cent.*
Opener-breaker motes and fly	1.00	0.95	0.86
Intermediate motes and fly	.93	1.17	1.16
Finisher motes and fly	.58	.94	.76
Total visible	2.51	3.06	2.78
Invisible	1.29	1.46	1.26
Total visible and invisible	3.80	4.52	4.04
CARD WASTE.[2]			
Flat strips	2.63	2.58	2.81
Cylinder and doffer strips	1.10	1.12	1.22
Motes and fly	2.04	1.99	2.17
Sweepings	.10	.12	.08
Total visible	5.87	5.81	6.28
Invisible	1.50	1.08	1.34
Total visible and invisible	7.37	6.89	7.62
PICKERS AND CARDS.[1]			
Total visible	8.15	8.61	8.81
Total invisible	2.74	2.49	2.55
Total visible and invisible	10.89	11.10	11.36

[1] Based upon net weight fed to bale-breaker.
[2] Based upon net weight fed to cards.

Referring to Table 9 and comparing the percentages of waste obtained from the different types of bales, it is seen that there is practically no difference between the amount of visible waste discarded, the figures being:

	Per cent.
Flat bale	8.15
Standard or railroad compressed bale	8.61
High-density bale	8.81

MOISTURE CONDITIONS.

Table 10 gives the average temperatures and relative humidities under which each type of bale was tested.

TABLE 10.—*Average temperatures and relative humidities during the testing of Delta cotton of 1⅛-inch staple.*

Type of bale	Flat.		Standard.		High density.	
	Temperature.	Relative humidity.	Temperature.	Relative humidity.	Temperature.	Relative humidity.
STAGE.	°F.	*Per cent.*	°F.	*Per cent.*	°F.	*Per cent.*
When opened	74	52	73	50	66	45
Finisher picker	72	51	72	45	72	50
Card	72	60	66	54	70	59
Drawing frames, 50 grain sliver	76	61	61	58	72	60
Roving frames:						
6.66 hank, fine frame	68	55	70	58	70	58
8.00 hank, jack frame	72	56	70	58	70	57
11.11 hank, jack frame	72	54	72	55	73	54
Spinning frame:						
30's yarn	69	63	74	68	69	63
40's yarn	75	65	77	68	75	65
50's yarn	72	69	75	64	75	64

Table 11 gives the percentage of moisture regain of the cotton at the various stages of the manufacturing process.

TABLE 11.—*Percentage of moisture regain in the Delta 1⅛-inch cotton at the different stages of the manufacturing process.*

Type of bale	Flat.	Standard.	High density.
STAGE OR SAMPLE.	*Per cent.*	*Per cent.*	*Per cent.*
From bale	5.95	7.05	6.26
From bale-breaker	6.22	6.59	6.04
Finisher picker lap	5.47	5.43	6.04
Finisher picker lap during carding	5.63	5.23	5.71
Card sliver	5.70	4.88	5.59
Finisher drawing sliver	6.58	5.18	5.87
Roving frames:			
6.66 hank, fine frame	5.04	5.93	5.37
8.00 hank, jack frame	6.38	6.32	6.38
11.11 hank, jack frame	5.76	6.10	6.26
Ring spinning frame:			
30's yarn	5.26	6.10	5.31
40's yarn	5.48	6.55	5.70
50's yarn	5.65	6.32	6.32

BREAKING STRENGTH OF YARNS.

The cotton of each compression was spun into 30's, 40's, and 50's yarn with twists equal to 4.25, 4.50, and 4.75 times the square root of the number spun. The average breaking strengths of these yarns are shown in Table 12.

Referring to Table 12 and comparing the breaking strength of the yarn spun from the cotton of the different types of bales, it is seen that there is practically no difference between the strength of the yarns spun from the different types of bales.

TABLE 12.—*Breaking strength in pounds per skein of 120 yards of yarn spun from Delta cotton, 1⅛-inch staple.*

No. of yarn.	New draper standard.	Twist multiplier.	Type of bale.		
			Flat.	Standard.	High density.
	Pounds.		*Pounds.*	*Pounds.*	*Pounds.*
30's	64	4.25	50.5	51.8	48.5
		4.50	51.6	51.3	48.6
		4.75	49.6	49.1	47.3
		Average..	50.6	50.7	48.1
40's	48	4.25	34.0	35.5	32.7
		4.50	33.6	35.0	32.7
		4.75	33.8	34.1	32.2
		Average..	33.8	34.9	32.5
50's	39	4.25	24.3	24.3	23.6
		4.50	24.3	24.3	23.2
		4.75	24.2	23.6	23.0
		Average..	24.3	24.1	23.3

None of the yarns broke as strong as the new Draper standard. This weakness is probably due to the excessive rainfall which delayed the opening of the bolls and the picking of the cotton.

IRREGULARITY OF YARNS.

The following figures give the irregularity of the sizings and breaking strengths of the yarns from the different types of bales:

	Sizing (per cent).	Break (per cent.)
Flat bale	2.06	4.53
Standard or railroad compressed bale	1.85	5.18
High-density bale	2.60	5.18

These figures indicate that there is practically no difference in the irregularity of the sizings or strengths of the yarns from the different types of bales.

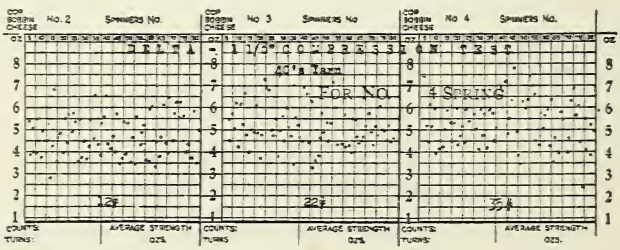

FIG. 3.—Irregularity of 40's yarn spun from Delta 1⅛" cotton compressed to different densities.

The results of the calculations of the irregularity of the yarns are verified by tests on the Moscrop single-strand tester. Figure 3 is a photograph of a chart made by this tester when breaking 40's yarn spun from cotton compressed to different densities.

Each dot on Figure 3 represents the breaking strength of a single strand of yarn 12 inches long. The greater the distance these dots are from a horizontal line the more irregular the yarn.

Plate V, Figure 1, is from a photograph of 40's yarn spun from the Delta 1⅛-inch cotton which shows practically no difference in the quality of the yarn spun from the different types of bales.

MANUFACTURING PROPERTIES.

There was no noticeable difference in the running of the different types of bales.

SUMMARY OF TESTS.

The results of this test show that compressing cotton does not injure its spinning value.

SPINNING TESTS OF WEBBER 49 COTTON OF 1¼ INCH STAPLE.

The Webber 49 cotton was compressed into four bales: A flat bale, a standard or railroad compressed bale, a high-density bale, and a high-density bale compressed in a wet condition. The latter bale was made by wetting a flat bale with water from a hose for a day and then compressing it to high density in the usual manner.

PERCENTAGE OF WASTE.

Table 13 gives the percentage of visible, invisible, and total waste obtained from the different types of bales.

TABLE 13.—*Percentage of waste from Webber 49 cotton of 1¼-inch staple; grade, Middling.*

Type of bale	Flat.	Standard	High density	High density wet.
PICKER WASTE.[1]	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Opener-breaker motes and fly	0.75	0.74	0.78	0.85
Intermediate motes and fly	.74	.81	.67	.75
Finisher motes and fly	.49	.56	.86	.87
Total visible	1.98	2.11	2.31	2.47
Invisible	1.75	2.13	1.33	2.36
Total visible and invisible	3.73	4.24	3.64	4.83
CARD WASTE.[2]				
Flat strips	2.95	2.93	3.27	3.85
Cylinder and doffer strips	1.08	1.10	1.22	1.20
Motes and fly	1.68	1.63	1.73	1.78
Sweepings	.06	.10	.10	.05
Total visible	5.77	5.76	6.32	6.88
Invisible	[4].35	.77	.42	[4]1.12
Total visible and invisible	5.42	6.53	6.74	5.76
PICKER AND CARDS.[1]				
Total visible	7.54	7.62	8.40	9.02
Total invisible	1.41	2.87	1.74	1.29
Total visible and invisible	8.95	10.49	10.14	10.31
COMBER.[3]				
Visible waste	16.72	16.68	15.83	16.92
Invisible waste	.32	[4].34	1.10	.53
Total visible and invisible	17.04	16.34	16.93	17.45
PICKER, CARDS, AND COMBER[1]				
Total visible waste	22.78	22.54	22.63	24.20
Total invisible waste	1.70	2.57	2.73	1.77
Total visible and invisible	24.48	25.11	25.36	25.97

[1] Based upon net weight fed to bale-breaker.
[2] Based upon net weight fed to cards.
[3] Based upon net weight fed to comber.
[4] Gain.

Referring to Table 13 and comparing the percentage of waste obtained from the different types of bales, it is seen that there was practically no difference in the amount of visible waste discarded from the flat, standard, and high-density bales compressed in a dry or normal condition, while the high-density bale compressed in a wet condition was about 2 per cent more wasty. The percentages of visible waste obtained from the different types of bales were as follows:

	Per cent.
Flat bale	22.78
Standard or railroad compressed bale	22.54
High-density bale	22.63
High-density bale compressed wet	24.20

MOISTURE CONDITIONS.

Table 14 gives the average temperatures and relative humidities under which each type of bale was tested.

TABLE 14.—*Average temperatures and relative humidities during the testing of Webber 49 cotton of 1¼ inch staple.*

Type of bale	Flat.		Standard.		High density.		High density compressed wet.	
	Temperature.	Relative humidity.	Temperature.	Relative humidity.	Temperature.	Relative humidity.	Temperature.	Relative humidity.
STAGE.	°F.	Per cent.	°F.	Per cent.	°F.	Per cent.	°F.	Per cent.
When opened	75	51	71	40	87	58	83	64
Finisher picker	75	44	73	46	83	63	87	58
Card	76	56	70	51	79	59	82	61
Comber	73	54	78	57	71	52	82	58
Drawing frames	70	52	75	57	66	51	82	55
Roving frames:								
7.30 hank, fine	72	56	71	55	71	55	72	56
10.00 hank, jack	72	58	72	58	71	57	72	57
12.00 hank, jack	72	58	72	57	71	57	72	57
Spinning frame:								
40's yarn	74	66	74	66	75	73	75	73
50's yarn	70	65	70	65	74	67	74	67
60's yarn	72	68	72	68	72	69	72	69

Table 15 gives the percentage of moisture regain of the cotton at the various stages of the manufacturing process.

TABLE 15.—*Percentage of moisture regain in the Webber 49 cotton at the different stages of the manufacturing process.*

Type of bale	Flat.	Standard.	High density.	High density. wet.
STAGE OR SAMPLE.	Per cent.	Per cent.	Per cent.	Per cent.
From bale	6.36	7.15	7.07	7.74
Finisher picker lap	4.17	5.57	6.67	6.27
Finisher picker lap during carding	6.06	5.53	7.79	7.72
Card sliver	5.78	5.40	6.84	6.85
Comber sliver	5.31	5.80	5.73	6.24
Finisher drawing sliver	5.54	6.15	5.59	6.21
Roving frames:				
7.30 hank, fine	6.38	6.67	7.07	7.41
10.00 hank, jack	5.26	4.98	6.15	6.21
12.00 hank, jack	5.87	6.15	6.60	6.6
Spinning frame:				
40's yarn	6.44	6.44	7.30	7.41
50's yarn	5.48	5.65	5.48	5.42
60's yarn	5.98	5.93	6.32	6.21

BREAKING STRENGTH OF YARNS.

The cotton of each compression was spun into 40's, 50's, and 60's yarn with twists equal to 4.00, 4.25, and 4.50 times the square root of the number spun. The average breaking strength of these yarns are shown in Table 16.

TABLE 16.—*Breaking strength in pounds per skein of 120 yards of yarn spun from Webber 49 cotton, 1¼ inch staple.*

No. of yarn.	New Draper standard.	Twist multiplier.	Type of bale.			
			Flat.	Standard.	High density.	High density wet.
	Pounds.		*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
40's	61	4.00	44.2	45.7	46.7	47.0
		4.25	45.3	47.0	46.0	46.0
		4.50	44.2	45.7	45.7	46.2
		Average..	44.6	46.1	46.1	46.4
50's	48	4.00	35.0	36.5	36.4	34.5
		4.25	35.0	35.3	34.7	33.8
		4.50	34.0	34.7	34.6	33.2
		Average..	34.7	35.5	35.2	33.8
60's	39	4.00	25.9	26.3	25.8	25.9
		4.25	24.8	25.9	25.5	24.9
		4.50	25.5	25.6	24.8	24.5
		Average..	25.4	25.9	25.4	25.1

Table 16 shows that there is practically no difference between the strength of the yarns spun from the different types of bales. None of the yarns broke as strong as the new Draper standard.

IRREGULARITY OF YARNS.

The following figures give the irregularity in the sizings and breaking strengths of the yarns spun from the different types of bales:

	Sizing (per cent).	Break (per cent).
Flat bale	1.92	5.51
Standard or railroad compressed bale	2.02	4.96
High-density bale	1.98	4.73
High-density bale compressed wet	2.00	4.68

These figures indicate that there is practically no difference in the irregularity of the sizings or strengths of the yarns from the different types of bales.

The results of the calculations of the irregularity of the yarns are verified by tests on the Moscrop single-strand tester. Figure 4 is a photograph of a chart made by this tester when breaking 50's yarn spun from cotton compressed to different densities.

Each dot in this figure represents the breaking strength of a single strand of yarn 12 inches long. The greater the distance these dots are from a horizontal line, the more irregular the yarn.

Plate V, Figure 2, is from a photograph of 50's yarn spun from the Webber 49, 1¼ inch cotton which shows practically no difference in the quality of the yarn spun from the different types of bales.

MANUFACTURING PROPERTIES.

There was no noticeable difference in the running of any of the bales.

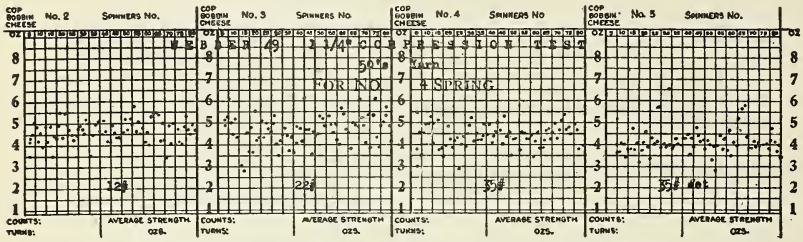

FIG. 4.—Irregularity of 50's yarn spun from Webber 49 cotton compressed to different densities.

SUMMARY OF TESTS.

The results of this test show that compressing cotton in a dry or normal condition does not injure its spinning value.

Compressed cotton to high density while wet increased the waste approximately 2 per cent, but did not materially affect the breaking strength.

CONCLUSIONS.

All of these tests showed that compressing cotton to standard or high density when in a dry or normal condition is not injurious to its spinning value.

Compressing wet cotton to high density either increases the percentage of waste or reduces the breaking strength of the yarn, or may do both.

Compressing cotton into a round bale with a hard core reduces the strength of the yarn about 7 per cent. If the round bale were to be run continuously in a mill, special opening equipment would be required.

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