used, then the diameter of 2.20's is  $V'(840 \times 10) = 92$  ends (nearly) per inch, and  $92 \div 2 = 46$  ends and 46 spaces per inch. There is a difference here between the 2.20's, or 1.10 and the 1.11's, which the first calculation gives; then the rest of the operation is as in the previous case. But there is another operation which should not be overlooked. The designer should know the weight of cloth he is going to produce, and should never put one into the loom without knowing it. Then all he has to do is to work in the usual manner, the weight of a square yard, or the weight of a yard of any given width, so that he can compare with any known cloth, and if too heavy or too light alter it to meet the requirements.

The weight of cloths may be altered in several ways; as by altering the number of picks or ends per inch, or a combination of the two; but in any of these methods the character of the cloth will be altered, probably, at the same time. In many cases that may be desirable for the development of some special feature, more especially in fancy goods, but there are cases where every characteristic of the original should be retained, and a complete knowledge of the method of changing weight and retaining the same character is of inestimable value in assisting in the development of some special feature.

It is obvious that any change in weight, where the same character of structure is to be maintained, must be governed by the relative diameters of the threads, and it is in this connection quite as much as in the first building of a cloth that the value of a knowledge of the diameters of threads, or a ready means of finding those diameters, comes in.

As pointed out in previous articles, the diameters of threads vary as the square roots of their counts; therefore it follows that the finer a cloth is the lighter-it is in weight, and the coarser it is, the heavier in weight.

Take a rough comparison. Lay a number of bars of iron four inches in diameter at a distance of four inches apart to cover a given area. Lay another number of bars of two inches in diameter at a distance of two inches apart to cover the same area. The relations between the bars and the spaces which separate them will be the same in both cases, but the relative weights of the two sets of bars will be as two to one, simply because the relative weights of the two sets of bars respectively will be as the squares of the diameters. Thus  $4^2 = 16$ , and  $2^3 = 4$ , cr as four to one, bar for bar. But the space between the bars being equal to their respective diameters, the relative weights in the aggregate is reduced to one-half, thus  $\frac{1}{2} \div 2 = \frac{3}{2}$ . Hence the relation of bulk and space being the same, the relative weights must be as 2 to 1.

The counts of yarn being indicated by the number of hanks to a given length per pound, or by the yards per pound, the higher the counts and the finer the thread except in one or two systems of counting—these counts represent the relative weights, therefore their sectional areas will serve as a basis for their relative diameters, and this must be in the ratio of the square roots of their counts.

Now suppose a cloth has been designed, and it is too heavy or too light, and it is necessary to alter it so as to bring it to a given weight, and yet retain every characteristic of the original. It is obvious that the relations between the diameters of the threads and the spaces between them must be maintained, and that the relations of warp and weft must also be maintained, otherwise there must be a change in the character of the cloth. Now suppose the warp to be 20's in any material, because so far as the principle is concerned, there is no difference in the treatment of the subject, and that there are 48 ends per inch, and the cloth is too heavy by, say, one-sixth. Then both the counts and the number of ends must be altered. If it must be reduced in weight one-sixth, there must be a finer yarn with a diameter one-sixth less than the original, or in the ratio of 6 to 7. Therefore the proposition will stand as  $6:7:v_{20}:v_{1}x$ , or what is the same thing as  $6^2: 7^2:: 20: x$ , which is a little over 27 as the required counts. But the ends per inch must be altered now to correspond with this, and this must follow on exactly the same lines, that is, the square roots of the relative counts. Then as  $1/20: \sqrt{27}::48: x$ , or in another form, as 20:27::482:x2, or reduced to its supplest form, as 6:7:48:56, so that 56 ends per inch of 27's will give a cloth of exactly the same character, but one-sixth less in weight than 48 ends of 20's will give.

If the cloth is to be made heavier, it requires to work in the opposite direction, lower counts and fewer threads, and the result must be correct, because it is based upon the strictest scientific principle.

## THE VALUE OF IMPROVED MACHINERY IN WOOL CARDING.\*

After a few words of an introductory nature expressive of the honor and pleasure he felt in meeting the club for the third successive year in the lecture course of the school, Mr. Bolger spoke as follows: "The carding department is to-day, more than ever before, the keystone of the arch upon the strength of which all woolen mills must depend for success, and, as time rolls by, the importance of this department becomes more manifest to all students of textile development, because the guality and character of the goods or yarns produced in every mill depends more upon the results in the card room and picker room combined than in any other department of the mill. But many manufacturers are not prone to recognize the truth or force of the above reasoning, and the result is, that while many woolen mills have thoroughly up-to-date weaving, finishing and dyeing equipment, yet their card rooms are neglected. To such manufacturers the fact should be plain enough, that while it is all right and proper to always have the above-named departments equipped in the best possible manner, with good men, methods and machinery, yet, if the carding department is out of date or répair, or if an incompetent man is in charge of it, the succeeding departments cannot obliterate the effects of the bad work coming from the card room, because if the yarn, which is the foundation of the fabric, that is laid in the picker and card rooms, is not satisfactory, the quality of

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