space around it, leaving room for future expansion, be properly equipped, and have a generous supply of windows. It is not within the scope of this article to deal with the labor-saving apparatus that conveys the coal and removes the ashes from the furnaces with automatic regularity. Our present intention is to bring home the fact of the need for an improvement in the actual structure and position of the boiler house, and to suggest reasons why these are essential.

It is, of course, necessary nowadays to study carefully every item of the fuel account, and to endeavor to get the utmost from each ounce of coal burnt, as well as to utilize all possible waste fuels to their utmost. But all these matters require intelligent co-operation on the part of the workmen employed in the boiler house, if the hard thinking in connection with the patent devices is to be given its best chance of succeeding. Intelligent employees will not be attracted to work in a boiler house that is tucked away in a dirty corner. The hygienic conditions of workers must be studied just as much in the boiler house as in any other part of the works, and it is upon a realization of this fact, that those responsible for designing new, or reconstructing existing boiler houses, must base their plans.

And, moreover, an intelligent operator, under the conditions we have roughly outlined, will be in a position to guide himself without hindrance, by the clear readings of the instruments placed in full light. His mind will not be clouded by the multitude of unnecessary details and the general atmosphere produced by grimy, badly-lighted, rubbish-strewn boiler houses.

Some conservative firms during the past have been inclined to scoff at such utopian ideas, but experience has shown both here and in other highly-developed industrial countries, that a boiler house requires one or two trained intelligent operators, who must work under conditions that are such as to keep their labor at its highest pitch of efficiency. When costs have been worked out, it has been found that under the old conditions, the expenses, through failure of plant or labor in its manipulation, was considerably in excess of those in a modern steam raising plant, provided with the necessary intelligent labor and installed under the conditions we have attempted to describe. Certainly "penny wise is pound foolish," where the boiler house is concerned.

FABRIC ANALYSIS.

Total Size, or Sizing Matters.

The amount of size, weighting, stiffening, or finish of cloth is determined by repeatedly boiling the sample with water, with or without the addition of substances to facilitate the solution of the starch, until a complete separation is effected. An error of some importance is sometimes made by considering *all* the matters removed by boiling water to have been added in course of manufacture. It has, however, been found that cotton loses about 2 per cent of its weight on repeated boiling with water. It follows that if this method of size abstraction be adopted, and no correction be made, that an absolutely pure cloth or yarn would be shown to contain 2 per cent of added size.

When the amount of size contained in a sample is relatively small, it is necessary to evaporate the washings to dryness and to weigh the residue, the purified cloth being only weighed (in the absolutely dry state) when the added size exceeds, say, 50 per cent. This procedure reduces the error due to the difficulty of obtaining exact results when weighing such a hygroscopic substance as absolutely dry cotton.

The amount of fibre mechanically removed from cotton cloth during the scouring is usually very small, even raised flannelettes seldom losing more than $\frac{1}{16}$th per cent in the process. If any doubt exists as to the complete removal of mineral matter by washing, it is well to ascertain the ash of the washed cloth, and, if necessary, to correct the result accordingly. In calculating the amounts of mineral substances present in cloth, it is necessary to subtract 1 per cent from the result found, to make due allowance for the natural ash of the cotton, the 1 per cent being calculated upon the weight of fibre present.

It is doubtful whether there are any substances extensively used in warp sizing that are not removed by boiling with water alone, but it is well to remember when soap is used in removing zinc or magnesium salts, that an insoluble mass is obtained, which may, however, be easily treated by adding small quantities of hydrochloric acid. Large quantities of paraffin wax, cellulose deposits, albumen, and perhaps some other materials will require special treatment. Some methods of dyeing introduce considerable quantities of mineral matter into the cloth, rendering extraction a difficult matter, or necessitating a comparative blank test on pure cotton. This shows what allowance must be made for the action of the reagent or chemical selected to effect removal.

Analysis of Size, Sizing Compositions, Finishes, etc.

The usual analysis of the composition of size comprises determinations of starch (flour), grease (tallow or paraffin), China clay or other minerals, zinc chloride, magnesium chloride, and moisture. Grey cloth may occasionally contain in addition one or more of the following substances: Glucose, dextrin, Irish moss, glycerine, calcium sulphate, Glauber's salts, epsom salts, oleine oil, common salt, soap, chloride of calcium.

The peculiar finish which distinguishes the production of some firms is not always capable of imitation when based on purely analytical grounds, owing to some peculiarity in the mechanical treatment (hot calendering, open steaming, beetling, raising, etc.) so that it is impossible in many cases for the analyst to imitate a finish from the results of his analysis alone.

As an instance may be given the well-known appearance of an "Epsom finish," the characteristic hardness of which may be almost entirely removed by what is sometimes known as "breaking down"; in this case the crystals entangled amongst the fibres are merely crushed, but this entirely alters the handle or feel of the cloth—analysis would not show any difference.

Stained, Tendered, or Otherwise Damaged Goods.

We have no hesitation in admitting that it is sometimes impossible to state the exact cause of damage to textiles, particularly when information has to be based upon the results of analysis of a single sample. All traces of the cause of the damage are sometimes absent, while, again, the indications may be so obscure that the cost of examination would be beyond all reason.

Mildew.

Chloride of zinc has been extensively used for the prevention of mildew, chiefly perhaps for goods that are to be shipped to warm climates. It has often been said that all sized goods sent to warm climates should contain this substance, and it is undoubtedly true so long as the additional use of chloride of magnesium, or packing in a moist state, is a necessity. Chloride of zinc has, in fact, gained so important a place as an antiseptic that there seems to be a danger of forgetting that so long as goods are packed in a sufficiently dry state, mildew is an impossibility. Several cases have been known where unsized or unbleached cloth or pure yarn has been returned from abroad in a mildewed condition, and wherever it has been possible to ascertain the amount of moisture when packed, it has been abundantly evident that the mildew has been due to an excess of moisture; further, it has been shown that isolated packages from the same consignments have remained sound, owing to normal or deficient moisture. This is, perhaps, one of the best reasons for resisting any increase of the existing standard of moisture.

When goods are packed in bale form, it frequently happens that the mildew is more distinct towards the sides or edges than at the centre, and this has often been taken as evidence of "external damage" from water. If we consider the greater amount of pressure present at the outer parts of the bale, along with the well-known preference which mildew has for growing in enclosed air spaces, we shall see that it is easy to attach too much importance to the distribution of mildew throughout the bale. The enclosed air spaces are found at the ends or edges of pieces, at the headings of knots in bundles of yarn, alongside string used in making-up separate parcels, and these places provide the best conditions for mildew growth. Such spaces, moreover, are the very places where the mildew grows most luxuriantly when this defect has attacked the whole package to some extent.

It is almost impossible, from an examination of a damaged sample, to distinguish between rain water that has penetrated through the packing to the goods in transit, and water already contained when packed; but sea water can generally be identified with certainty. If the goods contain antiseptics, however, it may in some cases be impossible to say whether sea water is present.

The amount of chloride of zinc required to prevent mildew is stated to be 8 per cent of dry chloride, calculated upon the weight of organic matter added in sizing. This amount is accepted as a standard, and cloths are only assumed to be mildew-resisting when they contain this or a greater amount of chloride. The above does not apply when magnesium chloride is present.

In deciding upon the cause of damage, it is not enough to attribute stains to mildew merely because they have the appearance common to this growth, but it is necessary to identify the mildew by observation of the fructification and filaments seen under the microscope. Stains caused by iron or grease frequently simulate mildew to a remarkable degree. The common acidity of mildew stains has frequently been overlooked, and we have known cause and effect to be transposed through failure to grasp this.

When goods are returned mildewed from abroad, it is always advisable to have an unopened bale or case returned, so that some idea can be gathered of the amount of moisture present in the goods at the time of packing.

The use of excessive quantities of paste for fastening tickets may also be mentioned as an occasional source of the excessive moisture and consequently a cause of the mildew growth.

Tendered Cloth or Yarn.

Difficulty frequently arises in deciding whether a sample of cloth or yarn is tender, the buyer and the seller holding entirely different views upon the particular case in point. They can seldom agree upon the definition of the word, and it is not surprising, since it admits of a comparative meaning, that both may have some grounds for their position. A broad trade meaning to the term is "below the strength common to the goods in question," but others will maintain that the meaning is "of such weakness that the buyer is entitled to reject the goods or to claim an allowance." Whatever meaning may be attached to tenderness, the only reliable ground upon which an opinion can be based or a conclusion arrived at as regards any particular instance, must be the strength test; this may be arrived at by ascertaining the breaking strain of the woven cloth, or where a comparison of tearing strain is more to the point, the separate threads of the cloth should be tested. This latter means of testing is frequently more valuable than the cloth test, because the results are directly comparable with the hand tests or rule-of-thumb tests practiced by buyers.

In testing cloth or yarn supposed to have been tendered by chemical action on the fibres, it is advisable to note the elasticity or extension of the sample, these figures frequently showing large differences between sound and tender yarn or cloth. It is of course necessary to compare the strength of the suspected sample with that of a sample admittedly sound, since it would be impossible in the present state of the industry to have standards for all kinds of cloth and yarn, sized, bleached and dyed goods. This is a branch of testing requiring much further investigation, particularly so in view of the greatly-increased importance attached in recent years to the value of the test.

Cloth is frequently tendered in the singeing proces previous to bleaching or dyeing. A determination of the amount of chloride of magnesium present in the grey cloth will at once show whether this substance has contributed to or caused the damage. We have known at least one case where the manufacturer was quite unaware that chloride of magnesium was present in his size-mixing until it was pointed out that one of his sizing compositions contained this substance without his knowledge. It must be mentioned that the ash of pure cotton naturally contains calcium and magnesium chlorides to a small extent. The quantities natural to cotton have been carefully ascertained, and the quantities found by analysis have, of course, to be reduced by the amounts natural to the cotton in order to find the amounts of added salts.

The tendering of bleached goods is frequently attributable to the imperfect removal of acid liquors, and it is taken for granted, so long as any mineral acid can be found in the cloth, that this is the cause of damage. It is frequently impossible to state the amount of acid found, since it is too small to be estimated by any means with which we are acquainted. By the special methods, however, it is not difficult to ascertain with certainty the presence of mere traces of acid. It frequently happens that goods have been tendered during some particular process, and that owing to a subsequent alkaline treatment or thorough washing, no acid remains; examination of the tender sample can then, of course, furnish no clue to the cause of damage. If the amount of acid left in bleached goods is small, no tenderness may be apparent for some time, but on protracted exposure to conditions of warmth and dryness the tendering may become very pronounced. Cloth has very frequently been found to be tendered when exported to warm climates, while the reference sample kept in this country has remained apparently or actually sound.

Testing Cotton Bleached for Gun-cotton.

Cotton waste and linters are bleached thoroughly previously to nitration for the production of gun-cotton; it is of great importance that the thoroughness of the bleaching must be of a high order, making it necessary to submit the bleached cotton to careful examination before it can be allowed to pass on to be nitrated.

The amount of moisture present in the cotton is one feature requiring determination. This is ascertained by placing a sample of about 20 grms. of the bleached cotton in a large weighing bottle and drying it at 105 deg. C., for three hours, or until no further loss in weight is sustained. The loss in weight is calculated to percentage of moisture.

For the determination of the ash 2 or 3 grms. of the sample are treated in a silica dish until well charred. The flame is then removed and the dish allowed to cool, when three or four drops of pure nitric acid are added and the contents cautiously heated for a few minutes, and then strongly, until all carbon has been consumed. The dish is then cooled in a desiccator, weighed and the ash calculated.

Fats are estimated by placing about 5 grms. of the dry sample rolled in the form of a cartridge, using fat-free filter paper, in a Knorr extractor and treating with ether for about two hours. The increase in the weight of the flask equals the amount of oil and grease. The flask containing the extracted matter should be dried at 105 deg. C., to remove the last traces of ether. Care should be observed that no cotton fibres are carried over mechanically, otherwise the results obtained would be erroneus.

The presence of acid is determined at the bleaching stage by testing the wash-water after the operation of souring. Two test-tubes are used, one containing a portion of the wash-water and the other distilled water. One drop of methyl orange is added to each test-tube and comparison made. When the wash-liquor matches the standard it is concluded that all acid has been removed, and that washing is complete.

At the bleaching stage tests must also be made for the detection of free chlorine. For this test a portion of the wash-water is placed in a test-tube, a few drops of acetic acid added, followed by a small amount of a solution of potassium iodide and starch. The production of a blue color indicates the presence of chlorine.

As cellulose is insoluble in alkalies, whereas hydrocellulose and oxycellulose are soluble, these characteristics afford a means of determining the presence or absence of the two forms of modified cellulose. A solution of caustic potash, 10 per cent, accurately checked against standard acid, is employed for the purpose. About 2 grms. of the cotton previously dried are placed in a beaker of about 250 c.c. capacity, and covered with 100 c.c. of the 10 per cent solution of caustic potash; the beaker is covered over with a watchglass, and the contents are heated at 100 deg. C. for three hours, during which time the cotton must be kept completely submerged in the solution. Any loss of liquor by evaporation during the period of heating must be compensated for by the addition of distilled water. After heating the required length of time, the contents of the beaker are poured into a litre of water in a larger vessel, any residue being washed from the small beaker to the larger. The alkali is then neutralized by an excess of acetic acid; any undissolved cotton is then filtered into a weighed Gooch crucible and washed successively with hot water, alchohol and ether, and dried at 105 deg. C. to a constant weight.

SILK FINISHING.

Silk Thread Finishing.

In connection with some classes of silk fabrics, more particularly that of taffetas, the subject of finishing the thread previously to weaving, is a most important question, since by means of it the thread is put not only in better condition for weaving, but the resulting face of the fabric is at the same time greatly improved.

Two makes of machines for doing this work are met with in the market, viz.: *The Keyworth*, and *The Pohl* Machines.

With reference to the *Pohl* Machine, the same is brought in the market in two styles, the Vertical and the Horizontal type of Machines. The object of the process of silk thread finishing is to lay the fibre, and at the same time to reduce the chance of the yarn cockling in the fabric, to a minimum, resulting in the production of a smoother, more lustrous face of the fabric. The treatment, as will readily be understood, increases the strength of the thread.

Pure Silk Fabrics.

Goods with plenty of silk in them, require no complicated finishing process; cleaning and rubbing, hot pressing, mangling, or light calendering, with or without friction, may be all that is required. Such fabrics are not sized unless a special stiff finish should be called for, or the weave be of such a far apart interlacing, that threads are apt to slip, and when sizing may partly prevent this.

Cheaper and lighter textured silks as well as Half Silks, however, are mostly sized, in order to make them appear thicker and stiffer, hence more acceptable for use, where otherwise they would not find sale.

Cleaning and Rubbing.

This is the process to which the silk fabric, as received from the weave room, is first subjected, the object being to remove any loose ends and knots, with the help of the burling iron and the scissors, or in connection with half-silks, *i. e.*, silk mixtures, also to remove any greasy, shiny spots, by means of rubbing them with sponges, soaked in benzine. Such places appear frequently in these fabrics after drying, more particularly in connection with goods which after the degumming process have not been sufficiently rinsed.

Cleaning pure silk fabrics, as mentioned before,