

means of transmission to larger power. As a result of a number of experiments he found that the following were the best ratios of diameters for ropes and pulleys :—

1	inch diam. rope	3	feet diam. pulley	ratio 1 to 28'8
1	"	4	"	" 1 to 32'0
1	"	5	"	" 1 to 34'3
2	"	6	"	" 1 to 36'0

In regard to power transmitted, it was found that when working under ordinary conditions the foregoing sizes of rope transmit, for each 100 revolutions per minute made by the pulley, the following :—

Rope	1½	inch diam. on 3 feet pulley would give	5	I.H.P.
"	1½	"	4	"
"	1¾	"	5	"
"	2	"	6	"

These figures may be exceeded under more favourable circumstances. The best angle of the groove on the pulley was found to be 45°, and the best speed of rope 3300 feet per minute. Illustrations and descriptions were given of many very ingenious forms of rope driving, by which power was conveyed from a driver to a single driven pulley under conditions that would have been impossible with belts, or in any case unless complicated trains of wheel gearing had been employed. In the discussion which followed the reading of this paper, a good deal of light for the uninitiated was thrown on rope driving practice. The importance of splicing was brought to the fore, and on this depends to a large extent the durability of ropes used for conveying power. A short splice will not do at all, and even the "long splice" ordinarily made by the mariner is insufficient. For 3-inch ropes the splice has to be 12 feet long; the strands being cut and divided, so as to avoid producing what sailors call a "gouty" length; that is, one where there is an increased diameter. Three patterns of rope are used; the three strand, four strand, and the served rope. The former is far the easier to splice, the latter the most difficult. A served rope, however, has the greatest flexibility; a very prominent virtue in a driving rope, as it leads to longevity, and enables smaller pulleys to be used without ill effect. In regard to material, cotton appears to be the favourite. It is almost universally used in England; naturally so in the Lancashire district, where rope-driving practice is so largely followed. In Ireland manilla appears to be most often used. There was one speaker, who came from India, and who said that he had used coir rope with great success; this is made from the fibrous material of the husk of the cocoanut. We should have thought this substance would have been altogether too elastic for the purpose. Another speaker, Mr. McLaren, had used rope-driving for ploughing purposes, but had gone far beyond the proportions advised by the author in his table. For instance, he had used a ¾-inch rope to transmit 40 horse-power, whilst his pulleys were no more than 20 inches in diameter. This rope we understood him to say was a manilla one, but the proportions seem altogether extraordinary. We should have thought a wire rope would have been more likely to answer the purpose. The speaker, however, drew the moral that too high a factor of safety was demanded by engineers in rope driving. Later on Prof. Goodman stated that he had calculated the average factor of safety in rope driving at about 90 per cent.

One of the excursions during the meeting was made from Belfast to Larne Harbour, to visit the alumina factory there situated. A description of this factory formed the basis of Mr. Sutherland's paper. Although, as is universally known, aluminium is one of the most abundant metals found in the earth, there are not many of the compounds containing it which render themselves readily to the extraction of the metal. Bauxite is the one generally used for its production, and large deposits of this have been found in County Antrim. The analysis is as follows:—Alumina is 56 per cent., corresponding to aluminium 29.9 per cent., peroxide of iron 3 per cent., silica 12 per cent., titanic acid 3 per cent., water 26 per cent. The peroxide of iron, silica, and titanic acid have to be separated out before the extraction of the metal from the alumina is attempted; and it is the function of the Larne works to carry on these operations; the smelting of the ore being done by electrical methods at Foyers. That, however, is an operation which does not come within the scope of the paper now before us, but may form the subject later on of another contribution in the transactions of the institution.

It is the Bayer process which is used at Larne. The bauxite, as received from the mines, is first ground and sifted, after which it is taken to a calciner in order to remove the organic matter present, which would prevent the subsequent separation of the alumina from the caustic soda. The calciner is an iron tube lined with fire-brick, and caused to revolve on rollers. It is inclined at a necessary angle, the heat from the furnace passing up through the tube. As the tube inclines, the bauxite travels to the lower end, and falls out into a receptacle. The alumina is extracted from the ground bauxite by treating it with a strong solution of caustic soda under pressure. This operation is carried out in Kiers. A soluble compound of alumina and soda (aluminate of soda) is thereby formed, while the peroxide of iron, silica, and titanic acid remain as an insoluble compound. The Kiers are steam-jacketed, and have paddles mechanically actuated to agitate the mixture. The steam pressure in the jacket is carried up to 70 or 80 pounds, and the mixture is subjected to the heat corresponding to the pressure for two or three hours until decomposition is complete. The liquid product of the Kiers is then passed through filter presses, the impurities being insoluble are retained, while the liquid aluminate runs into tanks. The residue, or cakes of impurities, are afterwards washed to extract as much of the aluminate of soda as possible; and the washings are used for diluting the product of the Kiers. Centrifugal pumps are employed for this purpose. At present the red mud forming the residue is useless, and there is an opportunity for any chemist to suggest a means by which it could be utilised. Experiments are being conducted in this direction by the Company. The lyes from the presses contained in the filter tank are afterwards subjected to another filtering process, being passed through cellulose, consisting of paper-makers' pulp. About fifty pounds of cellulose is boiled with water to a thin pulp, and is run upon sieves; it soon settles down, and is then ready to receive the lyes, arresting all finely divided, insoluble particles that have escaped from the filter presses. Finally, there is another filtering process.

It is now necessary to separate the alumina from the soda. This is brought about by the addition of excess of more hydrate of alumina to the hydrate of alumina itself, and in this way about 70 per cent. of the alumina in combination with the soda separates out in thirty-six hours. The hydrate of alumina is then pumped out of the decomposing cylinders, in which the latter process has taken place, sufficient however being allowed to remain behind in the cylinder for beginning the decomposition of the next charge of liquor admitted. The hydrate of alumina pumped out is filtered through filter-presses, and the last traces of soda are removed by washing. The hydrate of alumina is then taken to the calcining furnace, where the water of hydration is driven off at a low temperature, leaving the alumina perfectly anhydrous. It will, however, take up water again readily, and to prevent this it is heated to about 2000° F., when it becomes crystalline, and not so liable to absorb moisture. The weak soda liquors which are obtained are concentrated by a triple-effect evaporator.

On the afternoon of Wednesday he members and their friends were shown these processes in operation at Larne.

The last paper read was that by Mr. Stelfox. It was not discussed, the time for the conclusion of the meeting having arrived.

The Belfast meeting was a complete success, the whole arrangements being carried out most satisfactorily. A large number of the works of Belfast were visited by members, manufacturers being most liberal in opening their establishments to members, and generally showing that hospitality for which Ireland is renowned. The summer meeting of next year is to be held in Birmingham, the city in which the Institution of Mechanical Engineers had its origin fifty years ago next year.

#### OLD WORLD METEOROLOGY.<sup>1</sup>

IN the year 1508 a book was published in Germany under the title of the "Bauern-Practik." This book had a wide circulation. It taught the farmer, the sailor, the merchant—all, indeed, who were interested in the weather—what would be its

<sup>1</sup> "Die Bauern Practick. Neudrucke von Schriften und Karte über Meteorologie und Erdmagnetismus." Herausgegeben von Prof. Dr. G. Hellmann. (Berlin: A. Asher and Co., 1896.)

character, not only for the coming year, but in all future years. This book, with its many editions and translations, has now become very scarce, and a facsimile copy of the original has been reproduced by Prof. Hellmann, who, with the affection of the ardent bibliographer, has traced it with infinite difficulty through many libraries and into many unexpected places. To this little book, which consists of only eight or nine pages, the editor has added an introduction of some seventy, bearing the same relation to the original work that Falstaff's sack did to his bread. And just as Falstaff found his bread an unwelcome addition, so these last few pages are a hard nut to those who have not made a critical study of the German of the fifteenth century. But Prof. Hellmann's introduction gives great assistance, and by the help of it we have made out some of the rules and predictions, which appear quite as trustworthy as the prognostications that our modern weather prophets circulate, and in which no doubt they find their account.

The proper title of the book appears to be "In disem biechlein wirt gefunden der Bauren Prackctick unnd regel darauff sy das ganz iar ain auffmercken haben unnd halten." Under this title is a woodcut of a figure contemplating a crucifix, the whole surrounded by a scroll-work not badly executed. The text can be conveniently divided into three parts. The first shows how the weather, the harvest, the crops, and so forth, can be predicted from observations of the weather at Christmastide. If the weather is fair and clear on Christmas night, then there will be plenty of wine and fruit. If the weather be contrary, so will the matter fall out contrary. Then the wind is of importance. We understand the author, whoever he may be, to say that if the wind gets up at sunrise the year will be dear; but if the wind gets up at sunset, the king and the great lords will die. Like our modern prophets, the author is not afraid to indicate the course of political events. A fruitful year is foreshadowed by a west wind at midnight, but a southerly wind at midday betokens that there will be daily thunder. The author's word is "Krackhair," but whether we are justified in tracing it to "Krachen" must be decided by the student of old German. One can only regret that, with so simple a rule for his guide, one should be hindered from getting the full benefit, by his ignorance of the language in which it is written.

Then the author goes on to tell us what will happen when Christmas day falls on a Monday, Tuesday, and so on to Saturday; a very simple cycle, a little disturbed by the introduction of leap years, but nevertheless of great value to simple folk. With Christmas day on Sunday, among other things we are told that the summer will be hot and dry and fine, the autumn damp and wintry. There will be plenty of corn and wine and much honey, and if the text be correctly construed it says that "old people will die willingly"; but this seems such a contradiction to known facts, that the German must speak for itself to those who can understand it. "Die alten leüt sterben geren."

This is the kind of information that we get for each of the days of the week, and it is curious to notice the important part that honey plays in the predictions. He kills his king and his princes and his young men and his old women, but through all disasters he evidently remembers his honey, and in his partiality ranks it of equivalent importance to corn and wine.

In the next section we are told what will happen by the condition of the weather during twelve days, presumably between Christmas and Epiphany. The rules are very short, and are given without ambiguity or hedging. If the sun shines throughout Christmas day it indicates a peaceful year; if on the next day, however, money vanishes and corn becomes dear. But the third day presages something so awful that one must hope his translation is at fault. "So kriegen die bischof un die prelaten gern /uñ wirt irrung und den pflaffen." The spectacle of bishops, priests and deacons quarrelling is so opposed to our knowledge of their character, that some mistake has evidently glided in here, or the words do not convey the meaning which they apparently do to one only acquainted with modern German.

The book concludes with remarks of similar value on each month more or less depending upon Church festivals, and thus connecting Church observance with meteorological phenomena. This strikes one as an ingenious method of ensuring observance of the Church's calendar. If the sun shines on St. Vincent's day, we are told there will be much wine; if on St. Paul's day, a fruitful year. This last prediction recalls another of probably still older date. "Clara dies Pauli bona tempora denotat anni."

When the book passed over into a French translation a lighter

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note seems to have been struck, judging from the jingling rhymes by which it is recommended to the reader.

Prognostication nouvelle  
Des anciens laboureurs m appelle  
Je fus de Dieu transmise aux vieulx  
Qui m ont approuvee en tous lieux  
Et comme je diray motz a motz  
Les anciens ne font pas sotz  
Achepte moy quand m auras veu  
Car tu ne seras point deceu  
Je te donray une doctrine  
Qui te vaudra d'or une mine  
Et hardiment sur moy te fonde  
Car je dure autant que le monde  
Et si te veulz bien advertir  
Que je ne te veulx point mentir.

The contents appear, however, to be but a translation of the older German work, and the subject is regarded as too sacred and important to allow any license to the playfulness of French wit, to enliven the sobriety and heaviness of the German original.

In our own country, under the title of the "Husbandman's Practice," the book seems to have enjoyed a wide popularity. No divine authority was, however, invoked, but the predictions were fathered upon the astronomers, forsooth, and this too about the time that Newton published the "Principia," and Flamsteed was at work at Greenwich. The preface runs: "The wise and cunning masters in astronomy have found, that man may see and mark the weather of the holy Christmas night, how the whole year after shall be on his working and doing, and they shall speak on this wise."

"When on the Christmas night and evening it is very fair and clear weather and is without wind and without rain, then it is token that this year will be plenty of wine and fruit." And without much alteration or addition the rigmarole is translated from the German. From a remark of Prof. Hellmann, it is to be gathered that the legend of St. Swithin as a guide to the July weather did not appear in the early German editions. It first made its appearance in the English version some time before 1668.

We find it somewhat difficult to take the work of Prof. Hellmann seriously, the predictions are so crude and ludicrous; but it is impossible to read his preface without acknowledging the care and thoroughness with which he has done his work, and the labour he has bestowed upon the subject. The book itself may not be worth a second thought, but Prof. Hellmann has made it serve the purpose of developing two lines of investigation of great interest and importance, into which, however, we cannot adequately enter. In the first place, how are we to account for the widespread hold upon the public mind that such a book had, and for so long maintained as a popular treatise? Whence comes the deep-seated love of the marvellous and superstitious, which manifested itself in many ways, and in particular is connected with the twelve days about the time of the winter solstice, when the days are at their shortest. Prof. Hellmann endeavours with some success to trace evidences in the remote past of the tendency to predict the weather from observations made on these twelve days, each day corresponding to a month in the forthcoming year. That these days have become connected with a Christian festival is to a certain extent an accident of later date.

This observation of the weather about the time of Christmas is brought out more clearly in the second inquiry, when the question of the origin of the book itself is raised, or rather on the authority on which these wise saws rest. Discarding such modern authorship as Heiny von Uri or Thomas von Filtzbach can claim, the editor shows that the book, or at least the contents of it, circulated in a traditional or MS. form long before it took its printed shape. With difficulty he has traced and compared ten MSS., dating back from 1478, all possessing common features indicating a common origin, and pointing out with some degree of plausibility to the pages of the Venerable Bede as the oldest known source. But this wish to penetrate the future, and the formation of rules for general guidance are older than this remote date, and traces of ancient customs and old predictions are to be found in all parts of the globe, wherever written records have been preserved. But there is the curious fact to be remarked, that the older MSS. show a tendency to refer the grounds for prognostication to the Calends of January rather than to the Christmas festival, and in the case of a fifteenth century MS. both are mentioned. Christmas is quite a late innovation, and the growth in importance of the great Christian festival can be traced by its gradual displacement of the older Calendar in these meteorological superstitions.