nickel into the bath was for a time through the medium of ferro nickel. The material, which corresponds in a measure to the compound of iron and manganese known as ferro-manganese used extensively in the manufacture of steel, was prepared from ores of the two metals and subsequently introduced into the steel bath. This process of manufacturing nickel-steel is explained at length in the patent specifications of both Schneider and Marbeau, and has much to recommend it. It is only rational to assume that where two metals, iron and nickel, are already alloyed in the ferro nickel, the latter will become very evenly diffused through the steel bath when the ferro-nickel is introduced into it. At present the French manufacturers appear to have substituted metallic nickel in the place of ferro-nickel in manufacturing their nickel-steel; but in either case the nickel is introduced into the steel bath in the metallic form. In this country a different method has been employed by our nickel-steel makers—one which, when the object to be obtained is considered, does not commend itself either upon chemical or mechanical grounds. The nickel is introduced into the steel in the form of what is known as "commercial oxide," and the incorporation of a small amount (between 3 and 4 per cent.) of nickel, in the form of oxide, into a bath of steel so as to form a homogeneous alloy under the condition named is hardly to be expected. It is difficult to understand how the nickel can become evenly distributed throughout the bath, and if by chance the oxide should not be thoroughly reduced the cohesion of the whole mass is naturally weakened. A priori it would appear as though the European practice of incorporating the nickel in the metallic form were the one most likely to lead to uniform results, and the practice of using nickel in the form of oxide may account in some cases for the uneven results obtained over here. The production of alloy is not always an easy operation; but there are other metals forming component parts of alloys in common use, which possess essential characteristics so widely differing from each other that they are much more difficult to alloy than is the case with nickel and iron; yet practice and experience have overcome the difficulties at first encountered. Similarly happy results may be confidently expected in the case of nickel-steel when the manufacturers have gained the requisite experience, and probably occasion to refer to blow-holes or uneven distribution of the nickel will not then rise so often.

One point clearly established by experience with nickel-steel up to the present time is, that as far as applied to large castings the alloy has unquestionably come to stay, but to what extent it can be utilized for smaller articles remains yet to be proved. There appears to be no good reason why it should not eventually find general introduction wherever a tough steel of great tensile strength is required.

The non-corrodibility of nickel would seem to fit it especially for culinary utensils, and these have been placed upon the market for some time, manufactured both from solid nickel as well as combined iron and nickel plate, manufactured in the manner already mentioned. The method of welding nickel to iron and then rolling them both to plate, gives us a material possessing most of the desirable qualities of nickel without its excessive cost. Iron "plated" in this manner does not readily part with its nickel coating, as is so generally the case when it is plated by galvanic action.

Solid nickel coins have recently been issued by some of the European governments, and alloys of nickel and copper, the so-called "nickels" in common use, have long been in circulation in this country and elsewhere; but the uses to which metallic nickel is put to-day are comparatively few, and will probably remain so until improvements are introduced for reducing the metal out of its ores.

Engineering Instruments and their Calibration.—*Continued.*

generally be found that successive observations taken at the same pressures will not repeat themselves exactly. The lines will wander round about a mean position. If readings be taken first with rising, and then falling pressures, it will often be found that one of these will remain constant for successive repetitions, while the other varies owing to slight alterations in friction. Oftener, however, both will be found to vary together.

5. The atmospheric or zero line alters with alteration of temperature, and should therefore always be taken immediately after the diagram, time only being allowed for the complete escape of steam from the underside of the piston. This is naturally only important for measuring the absolute pressure of steam at any point of the diagram, and will not affect the mean pressure. If the atmospheric line be taken previously, the pressures above the atmosphere will all be too high. It is probable that this error is not so great in actual practice, where the spring has not so much time to fully acquire the temperature of the steam as in static calibration, where the steam is steadily applied for an appreciably longer time

The author finds that, for purposes of correction, all the foregoing errors may be summed up under two heads, viz., scale errors and backlash errors.

With regard to the former, the combined effect of rise of temperature and unavoidable inaccuracies in both spring and linkwork, is to alter the scale of the diagram so that the spring becomes of higher or lower scale than its nominal value. By plotting the errors of several cards taken at each of a number of successive pressures, an error curve may be drawn with a base line representing the successive pressures, and vertical ordinates representing errors. It can then be seen at a glance what the general character of the inaccuracies is. The curve generally approximates to a straight line, with larger or smaller undulations; and if a straight line be drawn through the mean values, it will usually be found to differ by less than 1 per cent. of the total pressure from any individual observation for a large portion of the range. In general, the actual observed errors will leave this line after a certain point, which will define the range beyond which the spring should not be taken. A spring which deviates widely from such a mean line should not be used where errors less than these deviations are important. A spring and indicator which show a less mean combined error than 2 to 3 per cent. is unusual. Many indicators, if taken beyond a 1½ inch range of diagram, exceed 10 per cent. errors from their true reading. These occur in both a positive and a negative direction. By the means of this correction line the true scale of spring in the given indicator can be determined. If observations be taken on both rising and falling pressures, two sets of readings will be obtained, one up, the other down. A second mean line will then have to be drawn, and the difference between the two will represent backlash errors.

In all such calibration, pistons, linkwork, and all moving parts must be oiled at frequent intervals, as would be done in practical use. Dryness or foulness of piston, etc., will, of course, largely modify the backlash. Under static tests, or with the steady and slow rise and fall of pressure which are necessary for the accurate determination of the pressure, it is probable that the maximum difference between the rising and falling position of the piston will be shown. In actual use, with the rapid alternations of pressure and quickly moving pistons and parts which then take place, it is probable that backlash may, to some extent, be reduced. On the other hand, any undue pressure upon the pencil point would very largely increase this effect. In some experiments made on this point, the author found that with engines running at a constant speed and doing constant work, by modifying the pressure on the pencil the diagram was altered in precisely the direction one would anticipate. The effect of backlash upon an indicator diagram would be to make too low an admission line too high an expansion curve and too high an exhaust line, as long as it remains straight or drops. If any drop in the admission line, or rise in the exhaust line, occurs, this effect would be reversed. This is precisely what the author found in the cases referred to. With straight admission and exhaust lines, increase of pressure on the pencil produced lower admission line, higher expansion line, and slightly higher exhaust. This indicates a method by which backlash can be approximately corrected for. Under the above conditions it will generally only be necessary to correct the admission line, as the expansion and exhaust lines erring in the same direction, the mean distance between them will be practically unaltered by backlash. Where the admission line falls, or the exhaust line rises, instead of being straight, it is the exhaust line which will require correction. This correction, of course, involves some trouble where a large number of cards have to be measured, and if backlash could only be avoided, or reduced to negligible dimensions, the simple correction for scale would alone be required.

An indicator has recently been introduced in this country which seems to promise great possibilities in this direction. It has a rotary in place of a reciprocating piston, and there being no linkwork of any kind between pencil point and spring, there is little opportunity for backlash. The friction between piston and cylinder has been reduced to a minimum. If the spring is initially adjusted out of the centre line, side pressure, and therefore friction, is caused upon the journals, increasing as the pressure rises, and there is some backlash. With the springs properly adjusted, however, the backlash is remarkably small. In the Crosby and Tabor instruments the springs are attached to the pistons by ball and socket joints, so as to allow them to adjust themselves if any slight deviation of the spring pressure should occur. But the danger of vertical play prevents sufficient slackness in this joint to render it always effectual.

It is curious that one of the indicators which the author tested, and which gave the most consistent results, had a spring from which the ball had accidentally become unfixed, though fitting it perfectly and sliding upon it without perceptible play. This seems to indicate that if this ball and socket joint could be made effectual, some of the irregularities due to piston friction would disappear. The backlash due to the linkwork was still present, however.

In conclusion, the author hopes that, in pointing out the possible values of indicator errors, he may in no sense be deemed to depreciate their value. A clear idea of what these errors are, and how they can be avoided and allowed for, must only tend to increased confidence in the indicator as a scientific instrument. If in any degree this paper has helped to attain that result, it will have accomplished the object the author had in view.

AUTUMN MEETING

OF THE

Mining Society of Nova Scotia.

Federation endorsed provisionally after a long and lively debate. The July papers discussed.

The Autumn meeting of the Mining Society of Nova Scotia was held at Halifax on Tuesday 6th instant. The attendance was not large but the proceedings were lively. There were present:

Mr. John Hardman, S. B., Halifax, *President.*
Mr. H. S. Poole M. A., A. R. S. M., Stellarton, *Past President.*
Mr. C. Fergie M. E. Drummond Colliery, Westville.
Mr. W. R. Thomas, F. G. S., Montague.
Mr. J. H. Austen, Halifax.
Mr. B. F. Pearson, Halifax.
Mr. W. G. Matheson, New Glasgow.
Mr. Chas. Archibald, Halifax.
Mr. G. F. Boak, Halifax.
Mr. A. A. Hayward, South Uniacke.
Mr. C. E. Willis, Halifax.
Mr. J. D. Sword, Halifax.
Dr. E. Gilpin, Inspector and Deputy Commissioner of Mines.
Dr. Murphy, Halifax.
Mr. C. F. Andrews, Country Harbor.
Mr. R. G. Leckie, M. E., Londonderry.
Mr. M. R. Morrow, Halifax.
Mr. Alex. Dick, C. and M. E., Halifax,

and Messrs W. H. Smith, J. E. Leckie and Mr. H. M. Wylde, secretary.

After the minutes of the July meeting had been read and adopted the following were elected:

NEW MEMBERS.

Mr. A. N. Whitman. Mr. J. G. Leckie. Mr. J. D. Sword.

FEDERATION.

THE CHAIRMAN—We have to go back as far as the March meeting on this matter, the whole question was referred to a committee consisting of Messrs Poole, Willis and the President and the Secretary. That committee formulated a scheme which was sent on to the Quebec Association, was amended by them and reported back at the Sydney meeting. The report is as follows:

"In the matter of Federation of existing mining societies or associations, it was agreed:—

(1) That in so far as the subsequent paragraphs are concerned, it is deemed desirable that all existing mining associations or societies in Canada should be invited to join;