2 francs the kilogramme it would cost 120 francs. Now a single factory with one printing machine ought to have at least 200 to 250 rollers, or a capital in copper only of 30,000 francs (£1,200), and in the case of large factories we find some that have as many as a thousand rollers.

For some time efforts have been made to find a less costly metal or alloy, which will render the same service, and with which can be employed, without important modifications, the methods of engraving that are at present in use. From 1883, M. Spiral, engineer at the National Foundry of Bourges, and M. X. Dépierre have analysed a whole series of rollers. The results of these analyses led M. Dépierre to attempt to experiment on different compositions which cost far less than copper. After many failures, he at last obtained satisfactory results, confining himself to the employment of non-arsenical zinc with the addition of a little tin.

Amongst the numerous difficulties which it has been necessary to overcome, one of the greatest has been that connected with the running off of the metal. It is well known that zinc is easily modified by the presence of very small quantities of foreign bodies. So M. Dépierre found that it was absolutely necessary to avoid arsenic. A homogenous mixture can only be obtained by rapidly running off the metal with a strong runner. This must be followed by very quick cooling, which ought to take place as far as possible under the action of considerable pressure.

When the metal has once been obtained, it is necessary to harmonise the usual methods of engraving with the usual qualities of the metal, and this is done in the following manner:—After the roller has been cast and turned to the required diameter, it is engraved in the ordinary way. When the first operation has been finished the metal is covered with a galvanic layer of copper, nickel or cobalt, or of nickel and cobalt, this combination yielding the best results. Experience has shown that a layer of about 0·06 millimètres of thickness is necessary, in order to resist the impression without injuring the engraving.

It has been objected that the imperfect adhesion of the galvanic deposit was an obstacle to the general use of this method of engraving. This objection was well founded a few years ago, but at the present day when a galvanic deposit can be applied at pleasure, it ceases to have weight, and in another direction the opposite method is employed. Formerly the copper was deposited on another metal, and then the engraving took place. Now the white metal is engraved, and only when the engraving is finished is the metallic layer deposited. It is the active impression which may influence the copper layer; now all practical people know that in many engraving operations which take place to-day, the rollers are galvanised several times, in order to obtain different degrees of intensity, and yet the deposit adheres perfectly. Another objection which may be made is that to the cost of, are added the difficulties connected with the installations for the galvanic deposit. This point, however, does not call for serious consideration. A third objection is that this new white metal is less tenacious than red copper. This would hold if the metal were very thin, say one centimètre in thickness, but if the metal is from 2 to 2½ centimètres of thickness the resistance is perfect.

The advantages presented by this system may be summed up as follows:—

1st.—Considerable diminution in the weight. This diminution is owing to the difference of the density, that of copper being 8·88, and that of white metal, 7. For instance, take a roller deposited in the technological museum of the Industrial Society of Mulhouse. This roller had under the new conditions a length of 90 centimetres, an internal diameter of 96 millimetres, a thickness of metal of 25 millimetres, and a weight of 61 kilogrammes 600 grammes. The same roller in red copper would weigh 78 kilogrammes, or 19 per cent. more.

2nd.—Cost of production. Another advantage, perhaps, the most important one, is the price. It is well-known that the price of copper, so far as the finished roller is concerned, is pretty nearly twice as much as that of zinc. Moreover, one-seventh is to be deducted in consequence of the difference in density, so that under the most unfavourable conditions a loss of almost 45 per cent. at least occurs by using copper compared to this white metal.

Copper requires for its fusion far more expense than zinc, copper melting at 1,092 degrees, and zinc at 440 degrees. The depreciation on the old metal is about 40 per cent. in the case of copper, and 50 per cent. in the case of zinc. Nevertheless, the difference in the capital sunk is in favour of the white metal.

The roller of white metal may be used for all sorts of printing, but is particularly appropriate so far as textiles are concerned, for handkerchiefs and cravats.

Machinery and Appliances.

THE REVOLVING FLAT CARDING ENGINE.

The flats upon the Revolving Flat Carding Engine should be so placed in relation to the main cylinder that the wire clothing with which they are covered will be supported in such near proximity to the wire clothing upon the main cylinder, that the cotton fibres passing between the cylinder and the flat shall be combed, carded, or cleaned, and laid as nearly even and parallel in their relation to one another as may be, the operation divesting the cotton as nearly as practicable of short fibre, fluff, dirt, shell, and other matter inimical to the production of good yarn.

By preference the point of nearest contact is that which is known as the heel of the flat wire. This necessitates that the working, or sliding portion of the flat shall be made bevel or taper in its relation to that portion which forms the foundation of the wire; this level requiring specially devised tools in order to its proper construction.

In considering the flat in its relation to the cylinder we have three specially variable elements to deal with:—

1st. In order to efficient carding the points of the wire upon the flat and the points of the wire upon the cylinder require to be maintained in a sharp condition, so that no particles of loose fibre or dirt may escape. In order to their maintainance in this condition, periodic grinding is required and resorted to, hence the wires upon the flat and the wires upon the cylinder are subjected to wear, and this causes the effective contiguity of the carding wires to be an ever varying quantity.

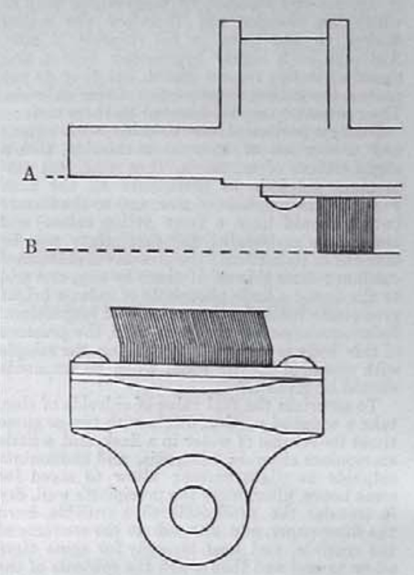
2nd. It is well known that in the revolving flat carding engine the flats are caused to traverse or "revolve" round the cylinder or that section of the cylinder which is covered by them, and that in their movement from back to front of the engine, they are supported by their ends resting upon what is technically known as the "flexible bend," which in most cases forms a course upon which the flats are caused to slide. This sliding or revolving movement cannot take place without a corresponding wear of the parts working in contact, and it is absolutely certain that from various causes each flat cannot wear equally with its neighbour.

3rd. A third element of variation is found in the fact that the flats are usually ground whilst supported from special facings, not being identical with those which support the flat during the operation of carding; these facings also are subjected to wear which will not be identical with the wear of the carding surfaces nor the wear of one flat equal to the wear of another.

Besides these elements of uncertainty which arise from the working of the engine, in the course of construction irregularities are certain to creep in, notwithstanding the perfection to which tools have been brought; the revolving flat card being a machine in which there are many parts that require to be made with the utmost accuracy in order to secure the best results.

Any arrangement which will tend to reduce the number of working surfaces, requiring accurate adjustment, and constantly liable to change, will be hailed by both spinners and machinists as a welcome improvement in this already admirable machine, to which so much skilled attention is now being given.

Inventors and machinists are giving a great deal of thought to the question of reducing the liability to error in the working parts of the Revolving Flat Card arising from the causes just mentioned, and with varying success. The relative merits of the many devices now before the cotton spinning public it is not the purpose of this article to discuss, but simply to state certain leading principles which appear to be important in order to secure the efficiency which is sought. As before stated, a considerable item of variation arises from the fact that the flats are not usually ground from the same sliding surface as is at work during carding, and this is now pretty generally admitted to be an item of considerable consequence. The problem at first sight appears to be a very simple one, *i.e.*, grind the flats from their working surface and so dispense with the "special facing" at the back of the flat as an element in the question of adjustment, and at the same time provide means by which any irregularity in the wear of the sliding part of the flat may not affect the working length of the wire between the supporting surface and the point of contact, the supporting surface being represented by the line A, and the wire in contact by the line B.



This, of course, is a solution of the question as regards the grinding of the flats, and if the points of the wires, the foundation of the wire, and the sliding or supporting surface of the flat lay in lines parallel the one to the other, the problem would be a simple one and easily managed, but as this is not the case and as, for the reasons above stated, the flats are commonly made with the sliding surface bevel, in relation to the points of the wire a more complex problem is involved, and how to guide or support the flats whilst grinding from the working surface so that the wire shall move in a line at right angle with the centre of the grinding roller, whilst the supporting surface maintains a diagonal position. There are many ways in which this is proposed to be done, but in the opinion of practical men, simplicity should be combined with efficiency in the accomplishment of this much-to-be-desired end; and the engine at present unique for simplicity should not be encumbered with more mechanism than is absolutely needful. It seems needful also that each flat should remain free to choose its own position in relation to the grinding roller, uncontrolled by any mechanism except that which acts directly upon its working surface. The question is undoubtedly one well deserving the very careful consideration of all users of the Revolving Flat Card. A simple and efficient arrangement by which the flats could be ground from their working surface, would not only obviate the evil arising from irregular wear of those surfaces, but would also prevent the mischief arising from wear, or the special facings provided for grinding at the back of the flats.

SETTING.

It is well known, as previously stated, that as the carding wires are worn down by grinding, the relative positions, of the flat and cylinder carding surfaces being thus changed requires to be re-adjusted by what is called "setting." This can only be done by reducing the radius of the bend or flat course upon which the flats are supported whilst carding.

The requirements of a flat course are that it shall form a rigid base for the flats whilst at work, incapable of deflection from the downward pressure of the flats, irrespective of the tightness or slackness of the chain which couples them together, that there should be no lateral strain upon the bend rendering it liable to vibratory movement from oscillation, &c. The bend should not be encumbered with moveable parts requiring to be replaced by others. There should be no parts liable to wear or displacement from oscillation or vibration. The bend should be simple, with the smallest possible amount of mechanism and the fewest sliding or fitting parts.

The setting should be done at one point only, if possible, and no more should depend upon the skill of the operator than can be avoided. The flat course should be made upon such principle that it will always maintain an absolutely true circle concentric with the cylinder and of varying diameter throughout the life of the wire, and should be capable of infinitesimal adjustment, say to the $\frac{1}{1000}$ part of an inch with facility. Periodic skimming up should be avoided if possible.

With a rigid bend provision is needed by which any wear of the cylinder bearings may be easily readjusted, although under ordinary conditions this readjustment should not be required for years.

IMPROVED CARDING ENGINE.

MESSRS. JOHN TATHAM AND SONS, LIMITED, ROCHDALE.

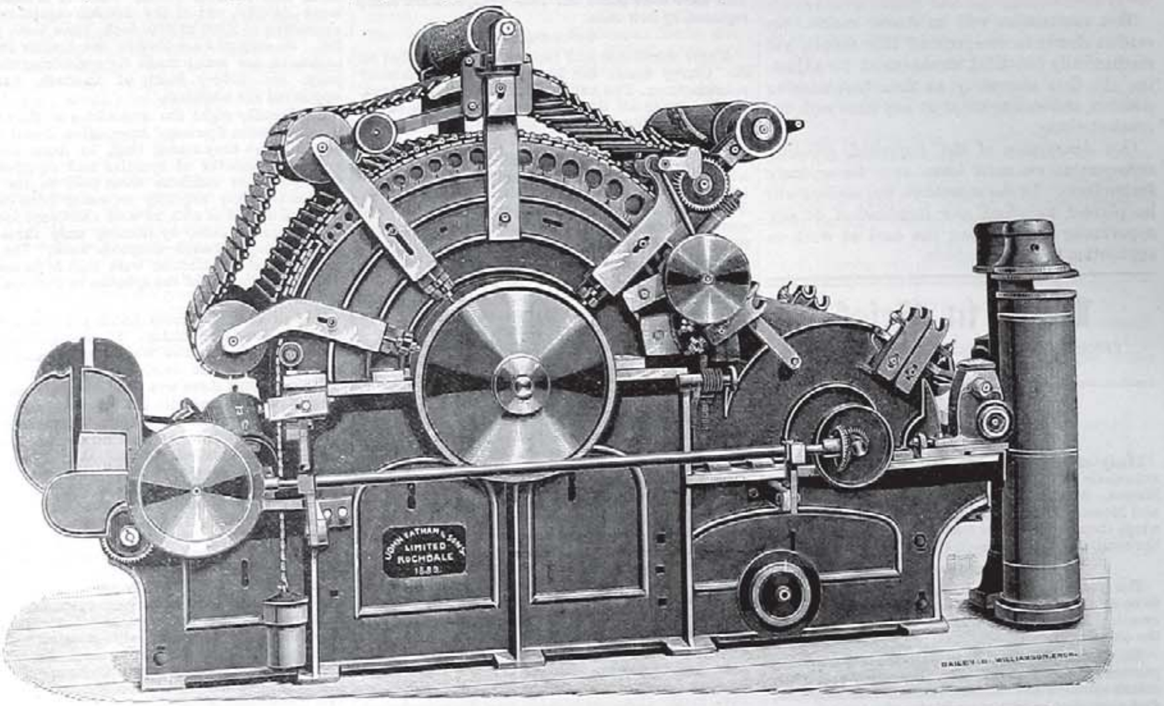
(KNOWLES AND TATHAM'S PATENT.)

Perhaps no machine has excited a stronger rivalry or a more extraordinary contest amongst machinists than the revolving flat carding engine. It would, however, be somewhat presumptuous in any one to declare that victory has as yet very strongly declared itself in favour of any of the leading competitors whose machines have at all become conspicuous candidates for the laurel wreath of the victor.

As is well known from many of our previous notices, the particular points that have demanded and received the greatest attention from inventors and machine makers have been—1st, the provision of a theoretically perfect flat course; that is, a course which throughout its length should maintain the chain of flats when working in a position perfectly concentric to the periphery of the cylinder; 2nd, to combine with this a capability of the finest adjustment to permit of the rectification of the relationship of the working parts when deranged by wear and tear; 3rd, the prevention of wear in the bearings of the cylinder, or the provision of facile means of securing perfect readjustment should such wear occur; 4th, to secure perfect rigidity in the flats when in their working position; 5th, to secure the working surfaces of the flat ends, and the bends upon which they move from wear; and 6th to secure the most perfect grinding of the flats by grinding them from their working surfaces. The respective makers have their several plans for dealing with these various points, but our present task is to draw the attention of our readers to those adopted by Messrs. John Tatham and Sons, and which are incorporated in their improved revolving flat card, which owing to these changes has become a strong aspirant for a first place in the estimation of the trade.

The first improvement incorporated in Messrs. Tatham's card, to which we call attention, is the improved flexible bend, the invention of Mr. Thomas Knowles, of Bolton. In this arrangement Mr. Knowles constructs the fixed bend of a peculiar form, making it, not as usual concentric to the cylinder, but upon such a line as would if continued, form a helix. Upon this is mounted the flexible bend, the inner surface of which corresponds to that of the fixed bend constituting as it would if continued an internal helix. Its outer surface on the contrary forms a true cylinder concentric in its periphery with the axis of the carding cylinder. This bend if laterally extended would make a wedge, and if its lower surface were placed upon a correspondingly inclined plane its upper surface would be a horizontal plane. To shew its action let us suppose the two parts to be arranged in this manner and the flexible bend to be advanced up the surface of the fixed inclined plane, the effect would be that its upper horizontal surface would be raised to an extent corresponding to the distance it had been moved forward. Withdrawn a corresponding lowering of the height of the horizontal surface would result.

As these movements of the two parts can be made over any extent, it will be obvious that a maximum, minimum, or any intermediate arrangement can be made as desired, and that the minimum can be reduced to the smallest conceivable movement. The adjustment is made by means of drag screws of a fine pitch, which



IMPROVED CARDING ENGINE, KNOWLES AND TATHAM'S PATENT.—MESSRS. JOHN TATHAM AND SONS, LIMITED, ROCHDALE.