produce the effect of embroidery. were woven, and only the finest productions were left to the embroiderer's art, who frequently made use of the already highly ornamented fabrics as a ground on which to trace his further artistic decoration. In the conservative Eastern countries much of this has survived, but in Europe the further improvement in weaving, especially through the invention of the Jacquard machine, and also the perfection attained in fabric printing, have driven embroidery, as a general means of decorating textile fabrics, almost out of the field, and its use may be said to be confined to the occasional decoration of small pieces for domestic or ecclesiastical purposes, with one notable exception. We refer to the embroidery of white fabrics with flat or crewel stitches, chiefly used for underclothing and similar articles which require frequent washing, and for which other ornamentation is unsuitable, or at all events not fashionable. This flat embroidery afforded about the middle of this century occupation to a large number of women, and replaced to some extent the loss they had suffered through the extinction of home spinning. Machine work, however, was not long in invading this field; and although this class of embroidery is frequently made by women as a pastime, it cannot be any longer classed among the remunerative domestic industries, though it has become an important manufacturing one which gives employment to a considerable number of operatives, the reduction in the price of such flat embroidery, or Madeira work, as the ladies call it, having been followed by an enormous increase in its consumption.

The present "hand" embroidering machine was invented in 1829 by an Alsatian, Josua Heilmann, but did not make its way till in 1850 Rittmeyer and Senn, of St. Gallen, in Switzerland, started the industry at that place, where it has still one of its principal seats, about 50,000 persons being engaged in it at present, while the exports of embroidered fabrics are valued at about £4,000,000. Its other principal locality is in the Saxon Vogtland and neighboring districts, and there are minor centers in Belgium and some departments of France, while in England and the United States it is of minor importance.

The machines used in this industry at present are of two sorts—"hand" and "shuttle" machines; and as these machines are comparatively little known and used in England, we think our readers will be interested by a description of them as made at present. We have selected two machines made by the Saechsische Stickmaschinenfabrik, vormalig Albert Voigt, who have a good name as makers, and have made many improvements in this class of machinery.

The machine usually employed for "holed" embroidery and fast festoons, or what is called Madeira work, is the flat stitch "hand" machine originated by Heilmann, driven by a hand crank, two treadles, and a pantograph guide. According to the number of needles, this machine makes in 12 hours about 700,000 to 1,000,000 stitches, while a practiced hand embroiderer can at most make 15,000 in the same time, so that the machine works 50 to 70 times as quickly. In all embroidering machines the material worked upon is stretched in a vertical frame suspended in the middle of the machine, and this frame is moved by means of a pantograph from side to side and up or down in all directions, and placed for each stitch, as prescribed by the pattern drawn upon a board to a scale six times enlarged. In the hand machine, two carriages, one on each side of the cloth frame, are moved backward and forward by turning a crank. On each carriage 112 to 224 iron tongs or grippers are placed at regular distances from each other, in two or three rows 4.5 meters (14 ft. 9 in.) in length, which guide the needles. The needles are pointed at both ends, and have the eyelet through which the embroidery thread is drawn in the middle, so that they can pierce the material in opposite directions without having to be turned. When by moving the front carriage the threaded needles are carried against the cloth, they pierce it and enter into the jaws of the grippers on the back carriage, which has been moved close to the cloth, on the opposite side, while the grippers are opened by pushing down one of the treadles. By forcing down the other treadle the jaws of all the grippers on the first carriage are opened and the needles released, and at the same time seized by the grippers on the opposite side, so that they are drawn through the cloth by the outward run of the back carriage as far as required to tighten the threads sufficiently. The cloth frame is then shifted by means of the pantograph, as prescribed by the pattern design, so that the correct places of the cloth are brought before the points of the needles, when the action described is repeated in the diverse direction. We may mention here that the designing of embroidery patterns occupies an important place among the industrial arts, over 1,000 persons being employed in it in Switzerland alone.

The original machine has received many improvements besides those referring to detail construction, among which the application of a boring apparatus for piercing the holes, where the pattern requires them, is one of the most important. This consists of rails fixed on hinges, one along each row of needles, and provided with four-edged steel points, which when the rails are turned down stand out centrally with and in front of each needle. Another set of rails are arranged on the back carriage, with a row of holes for receiving the piercers, and brought close to the cloth to prevent its giving way. The front carriage being run in against the cloth, the holes are pierced in the places determined by the pantograph as required, and then edged round. After piercing the rails are simply turned back, when the embroidering can be proceeded with.

For the production of the favorite festoon, banquette, or buttonhole stitch, the festooning motion is applied. It consists of long horizontal rails connected into a movable frame, which are placed in front of the cloth below the needle holders, so that, when the motion is thrown into gear, forks on the rails catch the thread when the front carriage is run in and form loops, which are held in their position till the needles piercing the cloth again from the back side are passed through these loops on the return stroke. When the front carriage is now run out, the forks withdraw from the loops into their former position and the loops are closed by drawing the threads tight toward the front, which forms the buttonhole stitch. On the carriage being run in again after the cloth is shifted by means of the pantograph, the forks are advanced again, and the action of the apparatus repeated.

The shuttle machine, which is principally used for embroidering net or tulle, has recently come into prominence. It produces about 260 times as much as an experienced hand embroiderer, as with 224 needles, or 112 in each row, it can make about four million stitches in twelve hours. Lately some machines have been made of double length, or nine meters (29 ft. 6 in.) on the needles instead of 4.5 meters, which would again largely increase the production, but whether these are a practical success remains yet to be seen. The shuttle machine differs from the hand machine previously described in having only one carriage in front of the cloth, with the needles arranged in two rows above each other. These needles are sewing machine needles with eyelets near the point, and at the back of the cloth a corresponding number of shuttles work on tubular carriers, which effect the binding of the needle threads on the back of the cloth. The motion of the carriage is effected by eccentrics keyed upon a longitudinal shaft and acting on the pins of the carriage rollers or wheels. The shuttles are moved by two eccentrics and lever connections, and an arrangement is applied for putting either the one or the other eccentric into gear according as a long flat stitch or a back stitch is to be produced, these two stitches requiring a different motion of the shuttle. While the hand machine is, as its name indicates, worked by hand, the shuttle machine is driven by power, one horse power, however, being sufficient for driving eight machines. This and the way in which the threads are bound on the cloth, and the greater speed, constitute the chief differences in the two kinds of embroidering machines. The shuttle machine is in fact a multiple sewing machine, with arrangements for determining the length and direction of the stitch in place of the feed motion.

Some of the details introduced by the Saechsische Stickmaschinenfabrik deserve a further notice. The needle threads are taken from the bobbins round a loose rough roller, and thence through a thread guide to the eyelets. In proportion as the thread is used up the roller is turned by the threads, by means of which an equal consumption and a uniform tension of all the threads is obtained. Another advantage is that by means of a brake on the roller more or less friction can be put on, and thereby more or less tension given to the threads, and that it can by means of a ratchet wheel on the roller be periodically quite arrested. The thread guide mentioned above serves to pull the thread, which is drawn to the back of the cloth by the shuttle passing through the loop, to the front again after each stitch, and to draw it tight before a new stitch is made, differing in this from the ordinary sewing machine, which pulls the thread tight by the needle piercing the cloth at the next stitch, such an arrangement being of course unsuitable for thin fabrics like net. To enable the workman to devote his attention exclusively to the pattern design, and thus work more quickly, a change bell is applied, which sounds when the needles are just drawn out of the cloth and the cloth frame has to be shifted by the pantograph. The machines are, if desired, provided with counters for registering the number of stitches, the work being usually piece work, and paid for at a certain rate per 100 stitches.

The other kinds of embroidering machines and improvements made by the makers our space allows us only to indicate shortly. These are: Shuttle machines 6 to 8 meters long on the needles; arrangement for coupling two machines in line, so that one embroiderer suffices to guide them; shuttle machines with one inch gauge, carrying 168 needles instead of 112 in the same length; apparatus for changing the colors on shuttle machines without having to rethread the needles; improvements in the motions by which the speed is increased to 80 stitches and more per minute; application of a convenient boring apparatus to shuttle machines; Martin's patent machines, which are arranged with hooks instead of shuttles, and can be run at 80 to 100 stitches per minute; combined embroidering machines, in which both "hand" and "shuttle" needles are employed, and which are provided with a boring and a buttonholing apparatus, as previously described, and are specially suited for colored embroidery in consequence of the facility with which hand needles can be changed.

While there are probably no hand embroidering machines used in England, shuttle machines have been supplied by the Saechsische Stickmaschinenfabrik to Messrs. Chamberlain's and Messrs. Perry's factories of Nottingham, through their agent, Mr. J. N. Johnson; and we see no reason why this trade should not be introduced more largely into this country, as the wages paid for embroidering form a small item in the cost of the finished material compared with the cost of cloth and thread and the interest on plant, and in some of these respects England has the advantage. We also think that there is a field open to embroidery as a means for the embellishment of furniture and dress fabrics to a much larger extent than it is used at present. The fact that four millions, or with double length machines even eight millions, of stitches can be made in twelve hours, renders it suitable for cheap and wholesale manufacture. It can easily adapt itself to fashion, as the preparations for new patterns are very trifling compared with those required in weaving; the workman has to change merely the pattern design before the pantograph, and the thing is done. Embroidery is not tied to a rectangular crossing of the threads, but can operate in any direction, obtain raised figures, pierce holes and work around them, produce "applique" effects by means of other tissues, while at the same time the length of thread used is only about double that seen on the face of the cloth, and with shuttle machines, a cheap back thread can be combined with a more expensive face thread. All these are important advantages compared with weaving, in which the preparations for new patterns of a varied kind require a considerable outlay; while for multi-colored designs the proportion of the total length of thread to that showing on the face is often very large. The number of colors in weaving is also limited to a greater extent than in embroidery, and on the whole we should think that embroidered fabrics would have a good sale and future. In length the design is limited by the gauge of the needles, which is usually 1½ in.; but by omitting needles, patterns 3 in., 4½ in., or 6 in. length can be produced, while the depth is practically unlimited. By combining pattern weaving with embroidery, especially rich and artistic effects could be produced, such as we at present generally only find in

Oriental goods preserved in the museums of art schools, but which the cheapness of machine embroidery might render accessible even to slender purses.—*Textile Manufacturer.*

APPLICATIONS OF FLAME TO HEATING PURPOSES.

By Prof. OLIVER J. LODGE, D.Sc.

THERE is little doubt but that the experience of many engineers and manufacturers is hostile to the complete combustion of fuel—technically called the consumption of smoke—regarded from the point of view of economy. In boiler fires it is continually found that as smoke is consumed, so is the output of steam decreased; and, so long as this is the case, it is hopeless to expect the non-emission of smoke from boiler fires, except under very severe penalties, which the community would be loth to exact. In high temperature furnaces, experience of smoke consumption is far less discouraging, and there are not wanting manufacturers to assert, on apparently good grounds, that they effect some 40 or 50 per cent. economy in coal now that they adopt a more perfect system of firing.

At first sight, economy of fuel would appear to be a necessary result of an enlightened design of furnace and of perfect combustion; and if in certain cases this result does not follow, but rather the contrary, there must be a reason, which it behooves one to discover. In the light of the researches of Mr. Frederick Siemens, the views of Professor Armstrong, and some recent experiments by Mr. Fletcher, the reason is not far to seek.

The first and obvious ideas on the subject were somewhat as follows: Smoke combustion has been attained by the admission of an extra supply of air at a certain point of the flame, so that none of the gas formed may distill over unburnt, but that all may meet with a due supply of fresh air, unsophisticated by passage through red-hot coke, and thereby deprived of its active element. It is plainly desirable to admit no more air than is necessary, especially when one considers that every cubic foot of oxygen brings with it four or five cubic feet of inert nitrogen, which has to be raised to flame temperature, and which acts simply as a cold diluent. Hence attempts are often made to proportion the supply of air to the supply of fuel, and to allow for the rapid evolution of gas which goes on directly fresh coal is injected. This can be done in two main ways—first, by making the extra air supply intermittent in quantity, to suit the intermittences of stoking, extra air being admitted every time a fresh shovelful is thrown in, and for some time afterward, as in Prideaux furnace doors; secondly, by letting the air supply be steady, but making the fuel supply steady also, as with automatic stokers. It is also plainly desirable to supply this fresh air not cold, but hot; and the waste heat of the furnace is, in the best arrangements, utilized to effect this.

This being all well known, I say the first and obvious idea as to the cause of the diminution of steam supply, when a smoke-consuming arrangement is introduced, is that either too much air has been introduced, or that it has been introduced cold. Either of these causes will certainly assist to produce the effect; but, considering that, however carefully they be avoided, no great economy of fuel results—at least in boilers—and considering that, unless air is so introduced, immense quantities of gas and combustible matter escape unconsumed, it is pretty plain that the cause of the paradoxical wastefulness of perfect combustion must be another and more deep seated.

Consider, therefore, the two classes of flame; one in which combustion is imperfect, the other where it is thorough and complete—for example, say a paraffin lamp without a chimney, and the Bunsen lamp of a laboratory. The one is luminous and smoky, its radiating or toast-making power, is great but it is unable to heat bodies put into it much, because it coats them so thickly with soot. The other is clear and non-luminous, its radiating power is extremely small, but it is supposed to heat bodies put into it very well; certainly it does so better than the other. But does it, after all, heat bodies put into it so perfectly? The answer, after consideration, must be: If they are such as can become white hot, yes; if they are such as remain comparatively cool, no.

A piece of thin wire, or ash, or dust, is well and perfectly heated; a cold soldering or flat iron, or a kettle, is slowly and very imperfectly heated. And why? For two reasons—first, because it interferes with combustion. For combustion, a certain temperature is necessary. Heat mixed oxygen and hydrogen to any temperature short of this, and they hardly combine at all; if they do, it must be a very slow process. Heat them up to the right temperature, and they burn at once. Now, a kettle of water introduced into a flame instantly cools a great part of it below the igniting point, and the gas burns in a very imperfect manner, as is evidenced by the irritating smell of acetylene. That is one reason, but that is not the whole; perhaps it is not the main reason. The second reason is, that the flame never really touches the body it has to heat. How can it? The body is at nothing like the temperature of flame, and accordingly no flame can exist in contact with it. Combustion is not only imperfect, it actually ceases within a short distance of the surface. A layer of dark, non-conducting air or gas, at some quite moderate temperature, intervenes between flame and kettle; and across this film, heat can only pass by radiation. No non-conductor is so perfect as air or gases. In so far as the film is warm, it may indeed impart some heat to the surface, but little; the great part of the heat has to be transmitted through the film by radiation from the main body of the flame.

But then this non-luminous flame is a shockingly bad radiator, and so very little heat really reaches the surface at all. What, then, is the remedy? There are two. Either the surface to be heated must be allowed to get red or white hot, and so permit the actual contact of flame without interfering with combustion, and without interposing a non-conducting, dark, gaseous layer; or else non-luminous flames must be abolished, and highly radiating ones used instead. The former is Mr. Fletcher's plan, the second is Mr. Frederick Siemens'.

If the bottom of a copper kettle, instead of being ½ in. thick, is say 3 in., or perhaps more, there is some chance that the outer skin of it may be raised to a

white heat by a perfect "solid flame" burner placed underneath it. In this case, combustion will not be interfered with, and a torrent of heat will pass through the copper into the water, the gradient being some 1,000 or more degrees per 3 in. Thus we arrive at the paradox that a thick bottomed kettle may boil water quicker than a thin one. This is not, indeed, Mr. Fletcher's way of putting the matter, nor is it his plan. He proposes a multitude of studs, or ribs, to project from the bottom of the kettle, or inside of the fire box, into the flame, to receive its heat without unduly chilling it. It seems to me that the thick slab is simpler, and likely to be more effective.

The other plan, that of Siemens', is to avoid flame contact altogether, to use a highly luminous and regenerated flame, and to work solely by radiation. This seems to me the better plan on the whole, especially as it avoids burning of surfaces.

Admitting that flame cannot really touch the ordinary surfaces which it has to heat, don't try to make it touch. Admitting that the heat of a flame must reach such surfaces ultimately by radiation, increase the radiating power of your flames as much as you can, so as to get the greatest possible advantage from them. This is probably the future method of applying combustion heat in all industries—rich gas supplied with intensely hot air, and burning at an excessively high temperature in free space.

Returning now to the consideration of ordinary smoke consumers, the reason of their lack of economy is, I think, manifest. Without such arrangements the flame is smoky indeed, but luminous; it contains plenty of solid matter, and, therefore, has considerable radiating power. Its temperature is, indeed, not very high, nor is the combustion at all perfect; but still, as it passes along the flue, it can send out a lot of heat to the surfaces; and even when the flame has ceased, the hot carbon particles continue their journey, and radiate as they go.

But admit sufficient air supply to render the combustion perfect, and note the change. A non-luminous or only partially luminous flame, almost free from solid matter, now passes along the flues, and radiates to them very little. True, cross tubes are inserted for it to play against; but, as we have seen, it cannot really touch them, it must do its heating ultimately by radiation, and it accordingly is unable to accomplish very much. It is not, indeed, necessary, or advisable, or customary in practice to admit air enough to render the flame really blue and non-luminous. I have only put an extreme case.

We may sum up the two cases thus: With smoke: Great escape of unburnt matter, both gaseous and solid, and low temperature flame, but good radiating power and large percentage of heat really given to the boiler. Without smoke: More or less complete combustion and hotter flame, but poor radiating power, and smaller percentage of heat produced really utilized; though, as more heat is produced in this case than in the former, the actual heat utilized may be much the same in both. With some arrangements one plan gives an advantage; with others, the other.

Evidently, to high temperature furnaces, where no cold surface need come near the flame, these considerations scarcely apply, and complete smokeless combustion can then hardly fail to be much more economical than incomplete; though, indeed, Mr. Siemens thinks that all solid contact interferes with a flame—inducing dissociation—and he accordingly endeavors to keep flames from contact even with white hot surfaces, and to work solely by radiation.

This seems to me the direction to look for perfection. To increase the temperature of a flame by regeneration; to increase its burning or radiating power by a sufficient supply of solid matter; to keep it out of contact with a solid surface, making it play down the center of flues, or causing it to form a sheet under and round a kettle; and to adjust the air supply so that combustion is quite perfect, and no unburnt or semi-burnt gas or solid matter escapes to cause noxious smells, and to foul the atmosphere.—*Industries.*

LEATHER DRESSING MACHINE.

ALTHOUGH the currying industry is one of great antiquity, an automatic leather dressing machine is in itself somewhat of a novelty. Apart from the interest in this respect attaching to Lockwood's automatic leather scourer and setting machine, shown in the machinery section of the Edinburgh Exhibition, and illustrated by our engraving below, the exhibit has claims upon our notice for other reasons. The ingenuity of design and accuracy of workmanship are fully evidenced in the ease, regularity, and precision with which it performs the variety of motions required. The machine, made by Arrol Brothers, of Germiston Ironworks, Glas-

gow, is an American invention. Frederic A. Lockwood, of Boston, Mass., is the inventor. While it is a comparative novelty in England, scarcely a dozen being at work, it is universally coming into use in the States, where, from extended experience of its labor-saving capabilities and the quality of its work, it has come to be regarded as a necessary to the currying industry. With two men in attendance, it is claimed that the machine can do as much work as seven men can do by hand, while the quality of the work is superior. The machine combines movable tools working in any direction required over a fixed oblong table of solid slate, which can at any time be quickly leveled up and adjusted by means of a series of set pins. The whole of the mechanism behind the table, which we may call the truck, together with the crane arms or brackets overhanging the table—which are rigidly attached to a fixed part of the truck—travels automatically in either direction along the length of the table, driven by a nut which bears against the truck and rotates on the screw shaft seen behind the table. This nut is rotated by reversible gear driven off the small pulley on the left side of the truck. That part of the mechanism inside of the crane arms which we may speak of as the carriage is automatically moved transversely in relation to the table by means of a screw-threaded shaft, the screw fitting a nut fixed to the rear part of the carriage. This screw shaft is rotated by an ingenious combination of bevel gearing and shafting, driven in their turn off reversible gear and pulley on the right side of the truck, similar to those on the left side controlling the travel of the truck

driven off the miter gearing on the main driving shaft above the truck at the speed of 240 revolutions per minute.

The machine works with either or both tools, which can be at once raised or dropped, and when working one tool is always in the table while the other is off, the two tools setting in opposite directions. The tools have a lifting motion imparted to them by the upper side of the tool carrier frame resting against the under side of rotating cam fixed to crank. The table, which is 22 ft. long by 5 ft. wide, is large enough to accommodate two or more pieces of leather simultaneously, in such a manner that one man can be preparing a hide at one end while the other man is directing the machine in the automatic setting out of a hide previously arranged at the other end. The working thus keeps two men constantly employed, but the physical labor is light, for the machine takes the brunt of this. Extra weight and extra size of leather are, it is said, obtained by the machine, as compared with hand work. Six are at work in Glasgow—three at Messrs. John Tullis and Son, engaged on strapping, and three at Messrs. Hamilton, Caldwell, and Sons on the lighter work connected with shoe leathers.

PHOTOGRAPHS EXHIBITING EXACT PERSPECTIVE.

ABOUT a year ago, Prof. Marey made known to the French Society of Physics the result of his experiments performed for the purpose of expressing by stereo-

CAZES' STEREOSCOPIC APPARATUS.

longitudinally. Both of these principal motions—i. e., the travel of the truck longitudinally and of the carriage transversely, relatively to the table—are by an interlocking controlled by one and the same guide lever, a small handle which may be seen hanging down in front of the carriage. The so-called "carriage" is in three distinct parts—the trundle frame, the head, and the yoke. The trundle frame is only capable of moving backward and forward transversely to the fixed table inside of the crane arms, bearing with it the head and yoke. The head is vertically adjustable with relation to the horizontally movable trundle frame, and is raised or lowered by turning the small hand wheel seen directly in front of the carriage, thus bringing the reciprocating tools nearer to or further from the table, giving pressures heavy or light as required, while the machine is in active operation. Below the head is mounted the yoke, carrying the guide rod, which receives the reciprocating tool carrier, which yoke is movable axially as regards the head and trundle frame. When it is desired to repeat the strokes in the same direction several times, the inventor has provided a latch capable of locking the yoke rigidly to the head, and preventing its revolving. The actual horizontal stroke is converted from the circular motion of the upright carriage shaft by a crank carrying a spur pinion which gears into an internal spur wheel situated in the yoke above the guide rod of the reciprocating tools. This upright carriage shaft is driven at the speed of 120 revolutions per minute, off the bevel gearing above the carriage on the so-called top-shaft, which top-shaft is, in its turn,

scopic photography the trajectory of a point that is moving according to the three dimensions of space, a problem that presents a certain interest for the study of the gait of man and flight of birds.

On taking two simultaneous photographs of the movement of a brilliant point with a stereoscopic apparatus, we obtain images that give the sensation of a well characterized relief. The trajectory assumes the appearance of a brilliant thread, bent in various directions, and the inflections of which vary with the nature of the gait. This has led to a discussion between Messrs. Marey, Napoli, Cornu, and Javal on the subject of the distances apart to place the objectives of the two photographic apparatus, in order to obtain the best conditions of stereoscopic restoration.

This is a problem that Mr. Cazes has endeavored to solve by putting it thus: What are the conditions to be fulfilled in order that two photographs of an object, A, shall give, through a simultaneous observation in the stereoscope, the same sensation as that which would be produced by a real object, A', like the first, but of different dimensions and placed at the distance of distinct vision?

When the eyes move in succession from one of the nearest points of the object, A', to one of the most distant, the visual angle and the accommodation change at the same time. When, on the contrary, we contemplate the two images at a fixed distance, the visual angle alone must change in order to superpose the various corresponding points, while the accommodation remains the same. Projections in the stereoscope cannot replace the object unless the latter has a maximum depth such that the eye, accommodated for the nearest point, still clearly sees the most distant one.

For a normal vision, v , of 30 centimeters (1.18 in.) such depth is about 3 centimeters (0.118 in.). It increases or diminishes with v , and we can, without sensible error, take it as equal to $\frac{v}{10}$.

In order to obtain two photographs of the object, A, identical with the two considered projections of A', the cameras must form with a point of the object, A, an angle equal to the visual one when we are looking at a point at the distance, v , say from 12° to 15° .

Let D be the mean distance of the object, A, from each of the objectives; f , the distance from the optical center of the objective to the image of the object, A, furnished in the camera; and d , the depth of the object, A, that is to say, the distance of the two extreme planes limiting the object, and at right angles with the bisectrix of the cameras.

The minimum distance of the object from the objectives will be determined by the relation

$$D = \frac{10}{v} f d.$$

The maximum of D is limited only by the small size of the negatives obtained.

By observing these conditions, Mr. Cazes has obtained some very interesting photographs of crystals, giving the sensation of accurate perspective, upon being examined in the stereoscope represented herewith.

IMPROVED LEATHER DRESSING MACHINE.