

sic (signed) William & L. Longmaid
 taken and acknowledged by William
 Longmaid (party hereto) at Plymouth
 in the County of Devon this 9th
 day of March 1846. Before me (signed)
J. Elliot Square a Master Extra-
 ordinary in Chancery - on the
 the twelfth day of March one thousand
 eight hundred and forty six years.
 His Specification is enrolled in the
 Records of Her Majesty's Chancery
 in Scotland by me John Ewart
 Deputy of Archibald McNeill Clerk
 or of said Chancery - (signed) John
 Ewart Deputy. -
 12 machines

Specification of Richard Prosser

Richard Prosser

To all to whom this presents
 shall come I Richard Prosser of
 Birmingham in the County of
 Warwick Shire Greeting Whereas Her
 present most excellent Majesty Queen
 Victoria by Her Royal Letters Patent
 bearing date at Edinburgh the eighteenth
 day of November one thousand eight
 hundred and forty five in the ninth
 year of Her Majesty did for Herself
 Her Heirs and successors give and
 grant unto me the said Richard
 Prosser my executors, administrators
 and assigns Her special license
 full power sole privilege and author-
 ity that I the said Richard Prosser
 my executors, administrators and
 assigns or such others as I the said
 Richard Prosser my executors, ad-
 ministrators

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administrators and assigns should
 at any time agree with and
 no others from time to time and
 at all times hereafter during the
 term of years therein expressed
 should and lawfully might
 make use, exercise and vendition
 in that part of Her Majesty's
 United Kingdom of Great Britain
 and Ireland called Scotland
 my Invention of Improvements
 in the manufacture of metal tubes
 and in the machinery and appar-
 atus for producing the same and
 in the apparatus for fastening tubes
 in their intended places in Steam
 Boilers and other vessels" In which
 Letters Patent is contained a Proviso
 that I the said Richard Prosser should
 cause a particular description of
 the nature of my said Invention
 and in what manner the same
 is to be performed and to cause the
 same to be enrolled in Her Majesty's
 Court of Chancery in Scotland with-
 in Four Calendar months next and
 immediately after the date of the said
 in part recited Letters Patent as
 in and by the same reference being
 thereto had will more fully and at
 large appear **Now Know Ye** that
 in compliance with the said Proviso
 I the said Richard Prosser Do hereby
 declare that my said Invention
 is described and ascertained in manner
 following and by the aid of the
 seventeen sheets of Drawings here-
 unto

invented (that is to say) the first part of my said improvements relate to the preparing of the edges of flat plates or sheets of metal for being turned up, as it is technically termed) into the form of tubes with the said edges meeting or nearly meeting. In order that a correct tube may be formed it is requisite that the flat plate of metal or sheet which is to be turned up into the form of such tube should be of uniform thickness and breadth. The usual process of rolling between revolving rollers in the ordinary course of manufacturing such flat plates or sheets when carefully performed will reduce the thickness to the requisite uniformity and at the same time the breadth may also be rendered tolerably uniform if every part of the said rolling process is carefully performed. But in order to obtain more precision in the breadth the two edges of the plate or sheet may be clipped with shears or otherwise cut or dressed by some subsequent operation. And the two edges of each plate or sheet have been in some cases further prepared for turning up by drawing the flat plate or sheet by power of a machine called a draw bench with an endway motion through between the cutting edges of a pair of fixed tools which edges are set so as to cut away a shaving from off each edge of the flat plate or sheet.

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sheet in order to render the breadth thereof uniform and so as to prepare the said two edges for fitting together when the plate or sheet is afterwards turned up into the form of a tube with the said edges in contact or nearly so by an instant one with the other in order by their contact and union by subsequent soldering brazing or welding to form the longitudinal joint or seam of the tube. The edges which are so to be brought in contact (or nearly in contact) have hitherto been prepared either by forming the flat or sheet with square edges (that is to say) the edges are at right angles to the flat surface of the plate or sheet suitably for those square edges meeting edge to edge after the turning up in which case the longitudinal joint or seam of the tube is termed by workmen a butt joint or seam. See figure A sheet 1. Or else the said edges have been prepared with what is termed feather-edged or bevelled edges suitably for overlapping with one feather edge over the other after the turning up in which latter case the longitudinal joint or seam of the tube is termed a lap joint or seam. otherwise a scarf joint or seam. See figure B sheet 1. The first part of my said improvements consists in preparing the edges of the flat plates or sheets by cutting out in the thickness

thickness of one of the edges of the metal plate or Skelp a concave groove or channel extending along all the length of that edge and forming the other edge of the same metal plate or Skelp with a corresponding convexity suitable for fitting into and filling up such groove or channel when the two edges are brought into contact or nearly in contact by turning up of such prepared plate or skelp into the intended tubular form. See figure 1. Sheet I. I prefer to make the said groove or channel of an angular form such as workmen term a vee groove from its resemblance to the letter V. the corresponding convexity of the other edge being in that case what workmen term a double bevelled edge. - But the precise form of the concavity and convexity is immaterial provided they are fitted one to the other so that when the flat plate or skelp is turned up or nearly turned up and that the two edges have been brought one towards the other so as to meet and begin to come in contact that they will do so by entering one edge into the other with a tendency to guide each other properly in the act of being brought into close contact and thereby cause the two edges to meet evenly without either edge being more or less remote from the central line of the tube than the other edge. - And when the said edges

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edges which have been so prepared with vee grooved and double bevelled edges for fitting one to the other (according to this part of my improvements) have been brought in contact (or very nearly in contact) by the turning up of the prepared plate or Skelp into a tubular form, the said edges by entering one into the other will tend to hold each other mutually in place so that each edge is enabled to resist displacement by the other edge from its proper place in the circumference of the tube, which is not at all the case with a butt-joint and is not so completely the case in the lapped joint for instance that edge which is innermost in a lapped joint may be forced inwards towards the centre of the tube or the other edge which is outermost in a lapped joint may be forced outwards from the same centre and when the said vee grooved and double bevelled edges of the turned up plate or Skelp are united together by soldering, brazing or welding as the case may be the surfaces which are so united together will be of greater extent than would be the case if the same tube had been made with a butt-joint being nearly of the same extent as if it had been made with a lapped joint. The vee grooved and double bevelled edges aforesaid may be formed at the two edges of each plate or Skelp

Skelp when the same is in its flat state by the usual mode of drawing the flat plate or skelp by power of a Draw bench with an end way motion through between the cutting edges of a pair of fixed tools - with suitable fixed guides for retaining the two edges of the plate or skelp as they move onwards so that they cannot fail to come properly in contact with the said cutting edges which are suitably formed for cutting out the intended Vee groove in one edge and for cutting double bevels on the other edge of the same plate or skelp, which mode of cutting is somewhat similar to that which is commonly practised for preparing flat plates or Skelps with feather edges suitably for being turned up to form lapped joints the only difference from what is commonly practised is that the cutting edges of the tools must be suitably formed for cutting the Vee grooved and double bevelled edges instead of feather edges - In sheet II part of a draw bench is represented with suitable cutters for preparing the two edges of plates or Skelps according to the first part of my improvements - Figure 2, is a side elevation of one end of a draw bench - Figure 3 an end elevation and Figure 4 an horizontal plan - AA in all the figures is one end of the long bench, B a long toothed rack which is moved endways by means of a toothed pinion in a horizontal

horizontal cross axis not represented but which is turned round by the power of Millwork in the usual and well known mode of those draw benches which act by rack and pinion. D is the slider fastened to the rack B and moving thereout along the bench A. - The Tonges F for taking hold of the end of the plate or skelp are carried by the slider D and the force wherewith the slider D is moved by the rack B is made to operate by means of a roller a in order to close the Tonges E so as to bite the end of the plate or Skelp F with a very firm hold for drawing it endways all which is as usual in draw benches in common use, G G is a strong frame fixed on one end of the Draw-bench A for sustaining pivots at the ends of two horizontal axes, a and b one situated over the other in the same vertical plane and each axis a and b carrying two circular wheels e g and f. h the circumference of those two wheels e f and g h which are one above the other meet together and overlap each other a little with close lateral contact so that the two form a pair of what is commonly called circular shears such as e f and g h each of which pairs of circular shears will cut one of the edges of the Plate or Skelp F when the same is drawn with a slow endways motion

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motion through between the said two pairs of circular shears e and g h by the pulling action of the logs B of the Drawbench: K K are vertical setting screws at the upper part of the frame C C, for adjusting the bearings for the pivots at the ends of the two axes a and b. Those axes with the wheels which they carry are free at liberty to turn round according to the motion which the edges of the Plate F will give to them as it is drawn endways through between the two pairs of wheels e f and g h the circumferences of those wheels are of steel and truly formed at their circular edges and at their flat sides. The two wheels e and g on the uppermost axis a are just so far apart that the space between them is the width to which the plate is to be reduced by the cutting or pairing of its two edges. The other two wheels f and h on the lowermost axis are nearer together as is shown in Figure 3 which also shows the lateral contacts between the overlapping circumferences of the wheels e f and g h which cause them to act in the manner of circular shears for cutting or pairing away a narrow shaving from off each of the edges of the plate F as it is drawn through between the said two pairs of overlapping circumferences and by such cutting or pairing the plate or Sheet F is brought to an uniform breadth with

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with its two edges cut smooth and straight and square to the flat surfaces of the plate. This first cutting of the two edges is only preparatory to the use of grooving and double beveling of the same edges which is performed immediately afterwards at both edges at once by means of Steel Tools L M which as they appear in Figure 4 resemble circular cutters with eight teeth. See also Figures 5 and 6 but they are not revolving cutters for they are fixed immovably and operate with only one of the eight teeth of each, that tooth applying its cutting edge to one of the edges of the plate F, and those two teeth which are operative perform in the same manner as two fixed tools would do to cut the edges of the plate F as it is drawn onwards with endway motion against the cutting edges of the said teeth. By the action of the Drawbench, one of the said Cutters L is for cutting a Vee groove along one edge of the plate F at the same time that the other cutter M is cutting a double bevel along the other edge of the same plate F. The said Cutters are represented on a larger scale in Figures 5 and 6 each cutter is made of a circular plate of steel and they are turned in a lathe to prepare their circumferences with grooves around them and the bottoms of those grooves formed one with the

vee groove and the other with a
 double bevel as shown by the edge
 views **L** and **M** figure 6 and after
 being so turned the said circum-
 ferences are cut out into teeth as shown
 in figure 5 and harden'd. The cutting
 edge of each tooth which is so formed
 will have a projection above and another
 below the cutting part which projec-
 tions result from the grooves which
 have been turned in the lathe as
 aforesaid and they will include the
 thickness of the edge of the plate
F between them one projection
 applying above the upper surface
 of the plate and the other pro-
 jection applying below the under
 surface of the plate and thereby they
 guide the edge of the plate **F** as
 it passes between them so that the
 vee groove or the double bevel which
 is cut by the cutting edge of the
 tooth will be in the middle of the
 thickness of the edge of the plate the
 cutters **L** and **M** are each firmly
 fastened upon a fixed upright pin
 which stands up from a horizontal
 cross slider **N**. Figure 2 and 4 that
 is moveable by a setting screw in
 order to advance the cutter towards the
 edge of the plate until its acting tooth
 will cut that edge in a proper manner
 the cutters **L** and **M** cannot turn
 round about their said fixed
 upright pins when they are in
 action but after the cutting edge
 of one tooth of either cutter is
 become

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 become blunt then that cutter can
 be put so much further round
 about its said fixed pin as to bring
 the cutting edge of the next tooth
 into action in place of the former
 tooth and then the cutter is again
 made fast wherefore each cutter **L**
 or **M** answers the purpose of eight
 fixed tools to be used one after
 another as they become worn but
 the cutting edges of all the eight will
 be precisely alike in form because
 of the mode of their formation in
 the first instance by turning in a
 lathe as already mentioned in case
 of the edges of the plate **F** cannot
 be cut sufficiently for completing
 the vee groove and double bevel at
 one time of passing the plate through
 between the cutters **L** and **M** in the
 Draw bench in manner aforesaid
 the plates may be re-passed a second
 or third or a fourth time as may
 be necessary with the said cutters
 advanced by the setting screws of
 their cross slides such as **N** Figure
 2 and 4 so as to cut the edges more
 and more until they are sufficiently
 cut with vee groove and double bevel
 corresponding to the other in prepara-
 tion for being turned up, and
 note fixed guides may if required be
 fixed to the frame **G** & **C** so as to
 bear against the two edges of the
 plate or Sheet **F** in order to retain
 the same in place sideways as it
 is drawn endway forwards by
 the

the Draw-bench - on the edges of the plates or Skelps may be cut with one groove and double bevils in a planing machine, the long moveable table of which is provided with a long narrow flat bed for receiving the Plate or Skelp (which must be previously set truly flat) with suitable means of fastening the flat plate down on the said bed which should be somewhat narrower than the breadth of the plate and raised above the moveable table of the planing machine in order that the edges of the plate may overhang the narrow bed at each side thereof suitably for being acted upon by the cutting edges of two tools which must be held in suitable tool holders sustained by the fixed part of the planing machine in a suitable manner and in the proper position for cutting the two edges of the plate at the same time one edge with a new groove and the other with a double bevelled edge. The said one groove and double bevils being formed in the usual manner of planing by as many successive cuts with the said tools from end to end of the plate or Skelp as may be requisite. The said means of fastening the flat plate down on the long narrow bed must be such as will be comprised within the space over the flat plate leaving the two edges thereof exposed in order that the fastenings may not interfere with

the Tools or their Toolholders, for this purpose the flat plate may be fastened down on the bed by a number of upright pinching screws in a strong bar extending over the flat plate all the length thereof and fastened at each end of the bar to each end of the bed leaving space between the upper surface of the bed and the underside of the said bar for the reception of the flat plate whereupon the said upright pinching screws in the bar being screwed down their ends will press on the upper surface of the flat plate at suitable places along the length thereof for fastening the flat plate down on the bed in a proper manner for being acted upon by the Tools on each side as aforesaid without any part of the fastenings for the flat plate being in the way of those Tools. And in place of cutting tools such as are most commonly used in planing machines two revolving circular cutters of Steel may be used with suitable teeth around their circumferences for cutting the metal of the plate or Skelp. They may be such revolving circular cutters as are used in machines for cutting or notching out the teeth of metal cog wheels, but one such circular cutter being adapted for cutting one edge of the plate or Skelp with

with a *vee* groove and the other such circular cutter adapted for cutting the other edge of the same Sharp at the same time with a double bevel. The said two revolving circular cutters must be fastened on two vertical axes which may be applied in the planing by being mounted in suitable bearings formed in frames, or carriages which may be sustained by the front part of the planing machine in place of the usual tool and tool holder thereof the said two axes and the circular cutters thereon being turned round with a proper velocity by any suitable toothed wheel work and Pulley work with endless bands in the usual manner of mounting sustaining and turning similar circular cutters in other cutting machinery. And each of the said revolving circular cutters may have two projecting circular rims one above and the other below the toothed parts of the circumference of the circular cutters these rims being smooth for applying against the flat surfaces of the plate at each of the border edges of its breadth the spaces between the said two projecting circular rims forming a circular groove round the cutter for receiving the said border edge of the plate which groove is truly adapted to the thickness of the plate in order to insure that the *vee* grooves and double bevelled edge shall be respectively cut in the true middle of the thickness at each of the two edges of the plate - and the very

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vertical axes of each of the circular cutters may be left at liberty to move a little up or down in bearings the bearings wherein the axes revolve so that each of the cutters may be able to accommodate itself to bearing opposite to the true middle of the edge of the plate which it is to cut according to the guidance which each cutter will receive from its said two projection circular rims whereby one applies in contact with the upper surface and the other in contact with the lower surface of the plate at the border edge or margin thereof and in case of using circular cutters in a planing machine in manner aforesaid the ordinary endway motion of the movable table of the planing machine must be reduced to a slow motion suitable to the rapidity wherewith the circular cutters can cut the two edges of a machine resembling a planing machine but simpler in its construction may be made for the purpose with no other parts than are requisite for operating in manner aforesaid with revolving circular cutters at the two edges of the plate at the same time for cutting out a *vee* groove in one edge and for cutting the other edge to a double bevel such cutting proceeding with a slow progress from one end to the other end of each of the said edges respectively the toothed circumferences of the revolving circular cutters may be formed of
Steel

flat squares or portions of a cylinder
 either formed by sand or other
 means into grooves formed in outside
 disks or tubes or steel which are
 mounted on the axis so that a
 set of such squares shall form the
 toothed circumference of a broader cut
 and the said disks or parts thereof
 may form the two projecting circular
 ends before mentioned as being one above
 and the other below the toothed part
 of the circumference of each circular
 cutter and instead of the flat plate
 being moved sideways in order to
 bring every part of its length in
 succession opposite to the said two
 revolving circular toothed cutters for
 cutting the edges thereof as aforesaid
 the table and bed wherein the plate
 is fastened down as already explained
 may be stationary and the two cir-
 cular toothed cutters with their
 vertical axes and the frames or
 carriages in which they are mounted
 respectively may be applied in a
 suitable moving frame or stage
 which is supported upon a horizontal
 straight edge fixed on each side
 of the table and bed parallel to
 the length thereof and the said edge
 being moved along these edges with
 a suitably slow progressive motion
 will convey the two circular toothed
 cutters along all the length of the
 plate in order to cut along every
 part of the two edges from one end
 to the other end thereof and wherein
 the task of revolving circular cutters
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seen into their sharpness if they were
 set upon which they operate has
 a rough scaly surface such as the
 edges of the plates or shingles would
 have when they come from the
 rolling without subsequent clipping
 or stripping of the edges it will be
 best to have the edges of the plates
 or shingles cut smooth and all the
 rough scaly surface removed before
 submitting them to the operation of
 the revolving circular toothed cutters
 as aforesaid. In some cases the edges
 of the plates or shingles are clipped
 with shears in order to render the
 width uniform as already mentioned
 in which case the rough scaly edges
 of the metal will have been removed
 and if they are cut tolerably straight
 the edges will be in a proper state
 for being cut with six grooves and
 double bevels by two revolving cir-
 cular toothed cutters in manner
 aforesaid. In Figure 7 sheet 22
 represents a pair of shears such
 as have been used for so clipping
 the edges and Figure 8 shows how
 a broad plate of metal is marked
 with a line in order to be cut along
 the middle of its breadth with the
 said shears for dividing it into two
 narrow plates or shingles and other
 lines for clipping the edges to render
 them straight and produce uniform-
 ity of breadth. A more complete mode
 of procuring would be to plane the
 edges of a number of plates or shingles
 at once by placing them edgewise
 upwards

upwards side by side upon the flat surface of the moving table of a common planing machine and planing the uppermost edges of the whole number to one flat surface; then if great truth is desired all the same plates or Skelps might be turned over on the surface of the table with the other edges upwards and those other edges could be all planed in turn to a flat surface; by this means both edges of each plate or Skelp would be rendered truly straight and parallel and the whole number of plates or Skelps could be made exactly alike in width and of the true intended width after such preparation by planing both edges straight, parallel, and square to the flat surfaces of the plates the true grooving and double bevelling of the same edges by a pair of circular revolving toothed cutters would be easily effected as there would be but little metal to remove by those cutters - and note if preferred two pair of such revolving cutters may be applied in the same machine so as to employ two cutters for operating and closely after the other on the same edge of the plate that pair of cutters which precedes and operates first on the two edges having coarse teeth and cutting away more than half the metal which is to be removed and the other pair of cutters which follows after the said first pair

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 pair having finer teeth and cutting deeper for finishing the true grooving and double bevelling of the edges to their intended state. The axes of both pairs of such cutters could be mounted and sustained by the same stodge and the cutting would be more rapidly performed than by one pair or three pair of such cutters might be used to follow one after another in the same manner as above described respecting two pairs and the cutting would be still more rapidly performed; the two pair which precede having coarse teeth and each cutting away rather more than one third of the metal that is to be removed; the third or last pair would finish the true grooving and double bevelling and note in case of tubes being required of a tapering form, that is larger at diameter at one end than at the other and like frustrums of cones, the flat plates or Skelps therefore (which will be broader at one end than at the other) may be prepared according to this part of my improvements with true grooved and double bevelled edges which may be cut in a planing machine either with the ordinary cutting tools of such machines or with revolving circular cutters in manner already explained except that the two edges of such plates or Skelps not being portable they could not both be cut at once in the manner already explained but the plate or Skelp may be first

first pasted on the bed or table of the machine up a suitable means for cutting one of its edges and afterwards returned therein in a suitable manner for cutting the other edge or both edges of such tapering plates or skelps could be cut at once in a planing machine, or a machine similar thereto, operating with revolving circular cutters as already explained provided that the frames wherein the vertical axes of the cutters are mounted are rendered capable of motion in a transverse direction or opposite to the ordinary motion of the plate or skelp so as to qualify the said circular cutter for acting upon the edges of the tapering plates or skelps in order to cut out a groove in one of those edges and to double bevel the other edges at the same time notwithstanding the variability of the form of the tapering plate or skelp because by the aforesaid motion in a transverse direction the circular cutters which are at the opposite edges of the tapering plates or skelps can be made to approach towards or recede from each other as the tapering form of the edges of the plate or skelp may require. and in like manner in case of tubes being required larger in diameter at the middle part of their lengths and smaller at each end the flat plates or skelps therefor which will be broader at the middle part of their lengths and narrower

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narrower at each end may have their edges prepared with the grooves and double bevels according to this first part of my improvements in manner last explained even although those edges should be curved lines instead of being straight lines. Sheet III represents another machine for preparing the edges of plates or skelps with the grooves and double bevelled edges according to this first part of my improvements, it operates by revolving circular toothed cutters. Figure 9 is a side elevation and Figure 10 a front elevation; AA in both figures are two fixed standards forming the framing. BD a pair of cylindrical rollers whose horizontal axes are sustained in the frame AA one roller B being above and the other roller D beneath the plate or skelp E and they hold the same between them so as to guide it to a proper level when it is moving onward and ways G and H are two revolving circular toothed cutters mounted on two vertical axes m and n which are sustained in bearings affixed to the frames AA and on the lower end of those axes m and n are bevel toothed wheels Z X which gear into bevel wheels on a horizontal shaft Y. the spur wheels a & b give motion to the rolls BD through the medium of the spur wheels c d and

and the spur wheel *W* gives motion to the circular cutters *G* & *H* the spur wheels *W* and *d* being on the same shaft *K* which is turned by suitable millwork, so that the Skelp to the groove is moved by the rollers *B*. In a straight direction between them while the circular cutters *G* & *H* operate by cutting a vee groove in one edge of the plate or Skelp and a double bevel on the other edge of the same plate or Skelp. In passing through between the pair of rollers *B* & *D* the plate *F* is retained at a proper level for the teeth of the revolving circular cutters *G* and *H* to cut the vee grooves and the double bevel in the middle of the thickness of each edge of the plate respectively. The plate *F* may be moved endways through between the rollers *B* & *D* and the cutters *G* & *H* by action of a draw bench at the end of which the machine is fixed in the same manner as already explained respecting the machine in Sheet II. And note the plates or Skelps of metal in the state in which they are left by the rolling operations whereby such plates or Skelps are manufactured may have their edges cut smooth and straight and parallel by passing the plates endways through between two pairs of wheels which are mounted on two horizontal axes one over the other in the same manner as the wheels *f* and *g* & *h*. and their axes

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axes *a* and *b* and frame *c* & *c*.
Figures 2 3 and 4 Sheet 2. as herein before described except that both the said axes with their said wheels are to be turned round by the power of millwork for effecting the cutting of the two edges of the plate between the overlapping circumferences of the two pairs of wheels *e* & *f*. and *g* & *h*. in the manner of two pairs of revolving circular Shears as already explained but the plate may be presented to the said pairs of wheels by a man and assisted if requisite in moving endways forwards as fast as the two edges thereof are cut by the action of the said two pairs of wheels which will in that way cut off a narrow strip from each of the edges so as to cut both at once and forming two smooth cut edges for the same purpose as is usually done by clipping along one edge at a time with Shears such as represented at Figure 7 Sheet II and already mentioned. The two edges being cut at the same time will be straight and parallel so as to reduce the breadth to uniformity and both edges will be cut at once in less time than one edge could be clipped with Shears. and note it is not new to employ one pair of circular wheels such as *e* & *f*. Figure 3 Sheet II to cut along one edge at a time in the manner of revolving circular Shears but it is new to combine two such pairs as *e* & *f*. and *g* & *h*. together for the purpose of cutting off

off the two edges of a plate or Skelp at the same time and with certainty of rendering the breadth uniform and the plate may be drawn endways through between such combined pairs e. f. and g. h. by power of a drawback or other similar machinery as already described in reference to Figures 23 and 4 sheet II. In which case the two axes a and b with the two combined pairs of wheels e. f. and g. h. are left freely at liberty to turn round as fast as the end-way motion of the plate requires them to do in passing through between them. On the two axes a and b with the two combined pairs of wheels e. f. and g. h. thereon may be turned round by the power of mill work applied to those two axes and the plate presented to the cutting action of the two combined pairs of wheels e. f. and g. h. by hand. And note in cases when it is required to cut a broad plate along the middle of its breadth in order to divide it into two narrow plates or Skelps in the manner already mentioned in reference to Figure 8 Sheet II then three pairs of wheels such as e. f. and g. h. and another third pair not represented in Sheet II but shown at l and m sheet II A figure 1 may be combined for cutting along the middle and at the same time cutting along each edge of such broad plate along the lines represented dotted in Figure 8. In such cases the two horizontal axes a and b Figure 3 Sheet

Sheet II must be supposed to be so much prolonged at the ends which are beyond the wheels g. h. as to admit of having another third pair of wheels of the same kind as the wheels g. h. fastened on the prolonged ends of the axes a and b the cutting edges of said third pair being at such distance from the cutting edges of the pair g. h. as will suit for the intended breadth of one of the plates or Skelps into which the broad plate is to be divided the distance from the cutting edges of the pair g. h. to those of the pair e. f. being suitable for the intended breadth of the other of the plates or Skelps into which the same broad plate is to be divided. Each of the axes a and b will therefore have three circular wheels fastened upon it as shewn at Figures 12. 3. Sheet II A and when the two axes are mounted in due place one over the other in their frame c. c. and their positions adjusted by their setting screws k k the said wheels will constitute three pairs suitably combined for the purpose of cutting along the middle and along the two edges of a broad plate at one operation in order to cut two plates or Skelps at once with straight and smooth edges and uniformity of breadth. The two axes a and b may be turned round by the power of millwork in order to produce the said cutting action of the three combined

combined pairs of wheels or the broad plate may be drawn endways by power of a Draw bench or other similar machinery through between the said the said combined pairs of wheels and in respect to these combined pairs of rollers as hereinbefore last described the frame G G must be increased suitably to the greater length that those axes must be and to the greater strain they will have to endure with three combined pairs of wheels instead of two pairs. That it B exhibits a machine for cutting two strips out of one sheet or plate of iron A B C. Figure 1 and 2 are shafts bearing a circular hardened steel cutter fixed upon each of them there are three other shafts A, D, C. Figure 1 but which cannot be seen in Figure 2 because they lie directly under the shafts A B C and are hid by them. these lower shafts A, D, C, have also hardened circular steel cutters fixed one upon each of the shafts, and the shaft A A and circular cutters 1. form a pair of circular cutters the shafts B and D and circular cutters 2. form another pair and the shaft C C and circular cutters 3 form another and third pair of circular cutters the pair of circular cutters 1 Figure 2, and the shafts on which they are mounted occupy one end of the frame and are intended to cut down the centre line of the Sheet of Iron. the

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the pair of circular cutters 2 Figure 2 admit of lateral or sideways motion so as to cut down one of the outsides of the Sheet of Iron at any required distance from and parallel to the first pair of cutters 1 Figure 2. the other third pair of circular cutters 3 Figure 2 admit of lateral or sideways motion so as to cut down the other outside of the sheet of iron at any required distance from and parallel to the first or centre pair of cutters 1 Figure 2. the cutters 2 and 3 admit of adjustment by the lateral motion of the frames in which they are mounted and when they have been moved to the proper positions on each side of the pair of circular cutters 1. they must be fixed by proper binding or clamping screws so as not to move accidentally while the cutters are in operation upon a sheet of iron. when perfectly adjusted and fixed the circular steel cutters 1, 2 and 3. Figure 2. may be used for cutting into strips any number of Sheets of Iron the cutters 1 dividing the Sheet of iron down the middle. the cutters 2, cutting a piece or band off one of the outside edges of the Sheet and the cutters 3 cutting a piece or band off the other outside edge of the sheet iron thereby cutting two parallel pieces out of and two outside bands or strips off one Sheet of Iron instead of cutting two parallel pieces or strips out of and four bands off one sheet

Sheet of Iron as is done in the ordinary and common method of shearing Iron for the purpose of being made into tubes for Steam Boilers. Figure 2 Sheet 2 B represents part of a Sheet of Iron out of which two strips or pieces have to be cut by the ordinary method a line a is drawn down the middle of the Sheet and the Sheet of Iron is cut by ordinary shears used in Iron works into two parts by this operation the workmen assisted by boys then present, each of these pieces and cuts a strip off each outside edge of each piece of Iron, and in this way the sheet of Iron. Figure 3 Sheet 2. B becomes cut into two pieces by five cutting operations producing out of one Sheet - two pieces and four bands of scrap from off the outside edges, the lines e b. and e d. Figure 3 represents the outside edges of the two strips the space between b and e is the band of scrap or waste and the part of the Sheet at e and d are the outside edges of the sheet which are also cut into bands of scrap - while by the use of the Machine shown at Figures 1 and 2, sheet 2 B, the sheet of Iron is cut into two parallel strips as shown at Figure 4 by three cuts a. b. e. and producing at the same time only two bands of scrap from off the outside edges b and e thereby effecting a saving of time and wear of tools of two cuts and also the saving of the piece of Iron between the lines e. b. figure 3 rotary motion

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motion is given to the circular cutters by suitable millwork the sheet of iron to be cut is presented to the first pair on the Shaft A and A1 then passed to the second pair on the shaft B and B1 and then to the third pair of cutters on the shaft C C1, on the Sheet may be passed in the reverse order giving of course a proper direction to the motion of the circular cutters and instead of preparing the edges of flat plates or Skelps with six grooves and double bevelled edges in the manner hereinbefore described the said edges may be rabbeted in the manner shown at Figure 2 Sheet 1 (that is to say) a rabbet is to be formed along one edge by cutting away at one side or surface of the flat plate or Skelp and another corresponding rabbet along the other edge by cutting away at the contrary side or surface - the bottoms of the rabbets so cut may either be parallel to the said flat surfaces or else may be bevelled as is sufficiently explained, explained by the figures. - the said rabbeted edges when they are brought together by the turning up of the plate or Skelp to a tubular form must correspond and fit one rabbet to the other so as to form a close longitudinal joint or seam along the length of the tube as is represented in figure 2 and such joints, which I term a rabbeted joint partakes of the properties of a common butt joint and a lapped joint combined the edges of the first plates or Skelps may

may be cut away with such rabbets by any of the means hereinbefore explained for forming vee grooved and double bevelled edges with such alterations of the cutting edges of the tools which are used as may be requisite for instance the rabbets may be cut by drawing the plates endways by power of a Draw bench between the cutting edges of the fixed tools or they may be cut in a planing machine or they may be cut with revolving circular worked cutters applied in any of the modes hereinbefore described or in any other suitable mould. And note in case it should be required to accumulate a somewhat greater thickness of metal at the longitudinal joint or seam of a tube by which the two edges of the plate or Skelp are to be united the thickness of that edge in which a vee groove has been cut may be increased by drawing the plate or Skelp which has been prepared in manner hereinafter described with a vee groove at one edge and a double bevel at the other edge by power of a draw bench through between a pair of rollers whereof one roller is formed with a double bevelled edge around its circumference for acting on the vee groove that has been previously cut along one edge of the plate or Skelp and the other roller is formed with a vee groove around its circumference for receiving

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receiving the double bevel that has been previously formed along the other edge of the plate or Skelp and in the passage between such pair of rollers the pressure which will be exerted by that roller which cuts in the vee groove against one or both of the borders of that vee groove may be caused to act so as to spread out one or both of those borders to an under angle in order to increase the thickness of that edge of the plate or Skelp along which the groove is formed beyond the original and proper thickness of other parts of the same plate or Skelp. In such case it is obvious that the vee groove as originally cut out in the edge of the metal must be a deeper and narrower or more acute angle than will be ultimately required for the vee groove; also that the double bevelled edge around the circumference of the roller must be formed with a wider or more obtuse angle than the vee groove as originally cut in order that the pressure by such roller may be able to produce the spreading effect above mentioned and thereby bring the vee groove to the proper obtuseness of angle which is required for fitting correctly to the double bevel at the other edge of the same plate or Skelp. In short the circumferences of the said two rollers must be so formed that by the pressure which they exert on the

the two edges of the plate or Skelp when it is drawn through between the pair whose edges will be left with a Vee groove and double bevelled edge properly adapted one to the other for fitting closely together when they are brought in contact with the turning up. Or instead of such rollers fixed steel tools with blunt edges adapted for rubbing with a burnishing (and not a cutting) action may be substituted and the plate or Skelp being drawn through between two such fixed tools by power of a Draw-bench they will operate on the Vee grooved and double bevelled edges in the same manner as the pair of rollers above described - and according to the form that may be given to the double bevelled circumference of the said roller or to the blunt edge of the fixed rubbing or burnishing tool, which may be substituted for the said roller so the increased thickness that is given to the edge of the plate or Skelp may be spread either at that side or surface thereof which will ultimately become the interior of the tube or else at the other side or surface which will ultimately become the exterior of the tube or the said increased thickness may be spread at both sides - This will be fully understood by inspection of Figure x Sheet V. and the same may be said respecting the preparing of plates or

or Skelps with rabbeted edges as represented at Figure 2 Sheet 1 and hereinbefore described for accordingly as these edges may be cut during such preparation as they may be made to produce an increased thickness along the joint or seam when the said edges are brought in contact by the turning up of the prepared plate or Skelp to a tubular form and such increased thickness may either form a prominence beyond the proper outline for the external circumference of that tubular form or else a prominence within the interior circumference thereof, or otherwise may form a slight prominence beyond the external circumference and another within the internal circumference - This will be fully understood by inspection of Figure y Sheet V and note in case of soldering or brazing the joints of tubes the plates or Skelps for which have been prepared with Vee grooved and double bevelled edges accordingly to the first part of my improvements and then turned up to a tubular form according to this second part of my improvements the joint may be slightly forced open by drawing a plug through the interior of the tube (whilst solder or spelter or brass wire with flux is put into the Vee groove and then the edges allowed to spring together and enclose the solder or spelter or brass wire in the joint in preparation for subjecting the tube to

to heat for melting the solder or spelter or brass wire and brazing the joint. The tube should be kept in a proper position during the heating with the hollow of the groove downwards so that melted solder will not escape. In case of soldering or brazing tubes with rabbetted joints the mode of proceeding will be nearly the same. - The second part of my said Improvements relates to the operation of turning up flat plates or sheets of metal to a tubular form. - the said flat plates are to be laid horizontally one at a time over the hollow of a long and somewhat broad gutter or trough of metal which serves for a mould - see a section thereof at *AA*. Figure 3 Sheet IV and the plate thereof *a*, *b* is a section is forcibly pressed down by a suitably formed solid tool of metal *BB* Figure 1. into the said hollow of the mould *AA* Figure 3. so that the two extreme margins of the flat plate *a*, *b* being those portions of the breadth thereof which are most immediately adjacent to the two edges *a*, *b* of the flat plate become bended up to the form of the two sides *d*, *d*. of the said hollow mould and the middle part of the breadth of the plate becomes bended to the curvature of the lower part of the solid tool *BB* Figure 1 for a first stage of the operation of turning up the form into which the plate is by that means bended.

bended for such first stage is indicated by the lines *e*, *f*, *g*, *h*, *i*. Figure 3 being like a hollow gutter or trough with a concave bottom *g*. and the two sides *f* and *h* ascending therefrom with a curvature which at the extreme edges *e* and *i* begin to be vertical and the two margins *e*, *f* and *h*, *i* which are adjacent to the said edges *e*, *i*. being bended to the curvature of any suitable small portions (for instance the drawing represents twelfth parts) of a circular circumference of the same size as the tubular form that the whole breadth of the plate will be ultimately made to assume by the final completion of the turning up; but the middle part *f*, *g*, *h*. of the breadth of the plate for an extent of five sixths of that breadth is only bended with an easy curvature *f*, *g*, *h*. during the said first stage and as to the two margins *e*, *f* and *h*, *i*. of that breadth (each of which margins is an extent of one twelfth of the whole breadth) the bending of those two margins during the said first stage being completed to the curvature of the intended tubular form as already mentioned, the said first stage is in fact a completion of the bending or turning up of two twelfths (or equal to one sixth) of the whole circumference of the tubular form that the whole of the plate will be ultimately made to assume by the final completion of the operation of

of turning up - The remaining five sixths of the breadth of the plate from f to h. being bended to an easy curvature at that first stage in part of the bending that it must ultimately undergo - and then for the second stage of that operation the middle part of the concave bottom f.g. of the said gutter which has been formed at the first stage as aforesaid is forcibly pressed by a suitably solid tool D figure 2. into the hollow of a long and narrow semicylindrical groove or trough E which serves for a mould and which groove E may if convenient be at the bottom of the hollow of the same mould AA as already described in Figure 3 or may be a distinct mould so that the said concave bottom f.g. will be bended down by pressure of the tool D and made to assume the curvature of the hollow groove E and exactly the curvature of the under part of the tool D Figure 2. and during such bending the two extreme edges e and i. of the plate will be turned up and brought one towards the other as shown by the dotted lines in approximation towards the intended tubular form until the said edges e and i have in that manner approached so near to the tool D as almost but not quite to touch the sides thereof - The bending of the plate is therefore brought by the second stage

stage to an incomplete oval curvature as is shown by the dotted lines in Figure 2. And then for the third and last stage of the said operation the ovally bended plate aforesaid is compressed between two long and narrow semicylindrical grooves with the angles along each side of each such groove rounded off see E and F Figure 3 Sheet II the said grooves corresponding one to the other like the two halves of a mould which when they come together will form a hollow cylindrical mould of the proper size for the exterior of the tubular form which the metal is intended to assume when the turning up is completed and by compression between the said two halves E and F Figure 3 of such mould the aforesaid extreme edges e and i which had (as already mentioned) been brought into close contact one with the other at this third stage and by giving a very forcible compression with the two halves E and F of the said mould after such contact has taken place, the turning up is finally completed to the intended tubular form which is represented by the dotted circle K^o. Figure 3 Sheet V. and note although the aforesaid description supplies (and the Figures represent) that such tubular form is a cylindrical form of the tube, and although a cylindrical form will most commonly be required nevertheless

nevertheless if any other tubular form such as elliptical or egg shaped or polygonal or other form should be required my mode of turning up will be the same as aforesaid but with the several hollow moulds suitably hollowed and the solid tool suitably carved for producing the intended tubular form and in like manner respecting tapering forms of tubes which are larger in diameter at one end than at the other end or larger in diameter at the middle of the length than at the ends the extreme edges of the flat plate or Skelp being suitably shaped for such forms of tubes and the several hollow moulds suitably hollowed and the solid tool suitably carved the turning up of such plates may be performed in the manner above described - and respecting the aforesaid first stage of the operation of turning up according to this second part of my improvements which stage is performed as already described by pressing the flat plate or Skelp into a broad hollow mould by pressure exerted with a corresponding solid tool as shown in Figure 1 Sheet IV the bending action during that first stage turns up the two marginal portions of the breadth of the flat plate or Skelp which are most immediately adjacent to those two extreme edges of the plate or Skelp which are ultimately to be brought together

together by the completion of the turning up and the degree of bending to be given at that first stage to the said two marginal portions should be a completion (or very nearly a completion) of all the bending that those two marginal portions will require when they are ultimately brought to assume their respective places in the circumference of the intended tubular form by the final completion of the turning up. The middle portion of the breadth of the flat plate or Skelp between the said two marginal portions is only bended to an easy curvature at the said first stage and respecting the aforesaid second stage of the said operation which stage is performed by pressing the aforesaid concave middle portion of the breadth of the plate or Skelp into a narrow hollow mould by pressure exerted with a nearly (but not truly) corresponding solid tool as shown in figure 2 Sheet 4 the bending action during that second stage should be solely operative on the said middle portion of the breadth and the degree of bending to be given at the second stage to the said middle portion should be somewhat more than will be required when that middle portion is ultimately brought to assume its proper place in the circumference of