of the intended tubular form. This is represented in Figure 2 sheet 4. where the curvature of the under part of the solid Tool D is shewn to be more rapid than the curvature of the hollow groove E beneath it and the plate is bended down to the said more rapid curvature of the under part of the tool D at the second stage, and respecting the aforesaid third and last stage of the said operation which stage is performed by forcibly pressing the hartly turned up plate or Skelp between the two corresponding halves of a hollow mould as shewn in Figure 3 Sheet 5. the bending action during that third stage should be chiefly operative on those portions of the breadth of the plate or Skelp which intervene between the aforesaid middle portion and the two aforesaid marginal portions of the said breadth and which intervening portions will not have been sufficiently bended at the two first stages The final compression at this third stage which as already stated completes the turning up after the two extreme edges of the plate or Skelp have come into close contact tends to compress all parts of the metal of the plate or Skelp to the exact form of the interior circumference of

of the hollow moulds. and as to the middle portion of the breadth which as before mentioned was bended at the second stage somewhat more than would be ultimately required that middle portion (during the said final compressure at the conclusion of the third stage) becomes rebended to its proper intended form as ultimately required. And in consequence of such overbending of the said middle portion at the second stage beyond what will be required and the subsequent rebending thereof at the third stage to what is required the two extreme edges of the plate or Skelp which have been brought into contact will be kept securely in contact owing to the metal having been set on a strain by the rebending with a tendency to close the said two extreme edges nearer together than their contact will allow and therefore they will not separate or quit contact of themselves after being released from the pressure and removed from the hollow mould. but considerable force would be required for separating them from their contact. And the degree of such overbending during the second stage should be such as by the rebending thereof at the conclusion of the third stage will cause the two extreme edges to spring together with as much force

force of contact as may be requisite and note in case it should be required to turn up flat plates – or shelps of metal to a tubular form with the two extreme edges brought opposite one to the other but not in contact so as to leave an open crevice of any required width between the said two edges such turning up may be performed by this second part of my improvements of a metal ruler of the same width as the said open crevice is required to be is fastened along with the summit of the hollow of the upper half of the mould which is used in the aforesaid third stage of the operation. in order that the two extreme edges of the plate or shelp may come in contact with the two edges of the said ruler at the summit of the mould at the same time and in the same manner as the said two extreme edges of the plate or shelp would (according to the foregoing description come in mutual contact one edge with the other and the said ruler keeping the said two extreme edges apart to a proper distance for the width of the open crevice which is intended to be left between them as aforesaid the metal of the plate or shelp will be then qualified for receiving that final compression at the conclusion of the third stage of the operation by which compression as already

already explained the turning up is completed and the metal made to assume the form of the hollow left between the two half moulds. and in this way by employing a ruler of suitable width within the mould flat plates or shelps may be turned up to any required portion of the circumference of a tube exceeding half for instance if the width of such ruler is equal to one fourth of the circumference of the interior of the mould then the plate or shelp which is turned will be three fourths of the circumference of a complete tube and so on of any other portion the breadth of the plates or shelps which are prepared for such incomplete tubes must in all cases be as much less than the width that would be required for a complete tube in the same moulds the width of the ruler which is to be fixed within the mould so that the breadth of the plate and the breadth of the said ruler will together make up the proper breadth for a plate or shelp which would be turned up to a complete tubular form in the same mould. And the flat plates or shelps of metal which are to be turned up in manner aforesaid may be prepared in any of the modes now in use for such purposes (that is to say) the extreme edges may be such as will be left by the rolling operation whereby the plates or shelps have been manufactured and brought

brought to their intended thickness and as nearly as can be done to their intended breadth. Or the edges so left may be afterwards dressed or clipped with Shears or otherwise to render them smooth and more correct in breadth and may also be cut more truly parallel by drawing the plates or Shelfs by power of a draw bench through between the cutting edges of fixed tools as hereinbefore mentioned. And the said extreme edges may be square that is at right angles to the flat surfaces of the plates or Shelfs suitably for becoming edge to edge or butt joints in the tubular form which will be given in the turning up. See Figure 1 Sheet 1. Or the said edges may be feather edged suitably for becoming lapped joints in the tubular form which will be given by the turning up see Figure B. Sheet 1 Or the said edges may be rabbeted or may be tongue grooved and double bevilled according to the first part of my improvements as hereinbefore described suitably for becoming rabbeted or tongue grooved joints in the tubular form which will be given by the turning up. See Figures 1 and 2 Sheet 1 But what I prefer is that the extreme edges of the plates or Shelfs should be prepared with tongue grooves and double bevilled edges according to the first part of my improvements as hereinbefore described.

described and then the turning up of the plates or Shelfs so prepared being performed according to the second part of my improvements as hereinbefore described the said edges will form a very close and firm longitudinal joint or seam for the tube which is produced by such turning up. See the section thereof Figure 1 Sheet 1. and as to the means of producing the requisite pressure for bending the plates or Shelfs of metal into hollow moulds according to this third part of my improvements as hereinbefore described in reference to Figures 1. 2. and 3. Sheet IV any kind of mechanical powers common ly used in machinery for pressing or bending metals may be employed choosing such as will be capable of exerting sufficient force of pressure for the purpose. The force that will be required will vary according to the thickness of the plate and the kind of metal and the size of the tubular form which is to be produced and according to the length of such tubular form or to the length thereof which is intended to be bended up at once. For the several hollow moulds and the solid tool hereinbefore described in reference to Figures 1 2 and 3 Sheet IV may be somewhat longer than the whole length of the plates or Shelfs of metal which are to be turned up in three moulds in which case very great pressure and

and great strength of pressing machinery will be required for bending the plate or Shelf in manner hereinbefore described throughout the whole length from end to end thereof at the same time. Or the said moulds and tool may be used suitably for bending only a portion of the whole length of the plate or Shelf at once in which case less pressure and strength may be requisite and after the bending of one such portion of the length has been carried as far as one of the three stages hereinbefore described (but no further) then by a repetition of the pressing in the same short mould and tool another adjoining portion of the length of the plate or Shelf is to be similarly bended in combination and so on portion after portion is to be subjected to the bending action in the same short mould and tool until the whole length is bended and brought to the same state as would have been done at once if the long moulds and tool had been used as above mentioned - But note with short moulds and tools and for bending only portions of the whole length at once the hollows of the several moulds must be enlarged at the ends of their length with easy curves in the manner of what are termed bell mouthed or trumpet moulded hollows in order

order that the plate or Shelf of metal may not be forced to change its State too suddenly from that portion of its length which is beyond the length of the mould and remains unbended thereby to that neighbouring portion of the length of the plate or Shelf which is bended in the mould to a more advanced stage of the bending. and of the transition from the bended to the unbended part of the length of the same plate or Shelf takes place with an easy curvature from one such part to the other the bending by repetitions as aforesaid will affect the turning up of a long plate or Shelf in a proper manner with less expensive moulds and tools and with less force of pressure and less expensive machinery for giving the pressure but the work of turning up must go on slowly in so bending by repetitions and therefore in manufacturing tubes in a large way it will be better to use long moulds and tools as already used for bending the whole length of the plates or Shelfs at once and to employ machinery of sufficient strength and power for exerting the great pressure which will in that case be required - and by way of shewing an example of one kind of pressing machinery which will be suitable among other kinds which may be used for the purpose

purpose. I will explain how the well known mechanical powers of a hydro-mechanical or hydrostatic press may be applied and two three or more hydrostatic cylinders combined into one press for acting in concert to produce like pressure along every part of the length of the long hollow moulds and tools before mentioned. see Sheet VI. wherein Figure 4 is a longitudinal elevation and Figure 5 a transverse section of a compound hydrostatic press with three cylinders N.O.P. which are lodged in a very strong horizontal frame Q.Q. to which upright pillars v v are firmly fastened at their lower ends and the upper ends of the same pillars v.v. are in like manner fastened to the upper horizontal part or head of the press R.R. - Each of the cylinders N.O.P. has a solid piston or plunger fitted into it commonly called the ram of the press see r in the section Figure 5 with a collar of leather applied around within the upper end of the cylinder N for close fitting around the ram r. and on the upper end of each of the three rams is a strong plate called a follower as at S.T.V. and upon these three followers the lower hollow mould A.A. is lodged and fastened by suitable screws - The upper mould or solid tool B.B. being fastened to the under side of the head R.R. by

by screws which suspend its weight the relative positions of the hollow mould A A and the solid tool B B above it appears in the section Figure 5 which is the same as Figure 1 and 3 Sheet IV already explained but on a smaller scale (the action) The action of the press is the same as that of ordinary hydrostatic presses and which action is well known, water is injected into the hollow of each cylinder N.O.P. by means of a forcing Pump and a conveyance pipe therefrom to the said hollow and the water acting beneath the lower end of the same by the hydrostatic pressure forces the ram the more up out of the cylinder through its collars of leather above mentioned with a very great force, all which being as usual in hydrostatic presses requires no further description but in the present case the said conveyance pipe from the injecting pump must communicate equally by branches with all the three cylinders N.O.P. in order that any quantity of water which is injected by the pump may distribute itself equably amongst the three cylinders and then the three rams thereof will be forced up with equal force and motion because they are all precisely of the same diameter and they act by their followers S.T.V. beneath the lower hollow mould A A at equal distances

distances apart along the length thereof and the force required for bending the plate or Shelp of metal will be required to act at all parts of the length of the long moulds A A and upper mould or solid tool B B. The injecting Pump may be worked by power of a steam Engine or other power and a loaded safety valve must be applied to some convenient part of the Pump communicating freely with the interior of the said conveyances pipe in order to permit the water to escape by lifting that loaded valve whenever by continuance of the injection of water by the Pump into the interior of the three cylinders has been continued until the hydrostatic pressure on the valve and consequently the hydro mechanical force exerted by the three rams to press the lower hollow mould A A upwards towards the upper tool B B has became as great as it is intended to be and if the injecting pump continues to be worked after that pressure has been attained then the said loaded safety valve will allow all the water which may be afterwards forced by the Pump into the conveyance pipe to escape therefrom into the open air without entering into either of the cylinders or causing any increase of the force exerted by the rams. – Wherefore by loading the said safety valve more or less the force of pressure that will

will be exerted to force the lower hollow mould A A upwards towards the upper tool B B, and consequently to compress the plate or Shelp of metal between the two can be limited to what is required without risk of exceeding the intended limit all which is as usual in hydrostatic presses and therefore requires no further explanation but the facility wherewith the pressure can be thereby limited and the great force which can as is well known be exerted by hydrostatic cylinders renders them a very suitable mechanical power to be applied for this purpose. – The manner of performing the operation of turning up by the said press is as follows For the first stage of the operation the long hollow tool A A being lodged and fastened in its place on the three followers S T V. and the upper solid tool B B being fastened beneath the head R R. of the press as they appear in the section Figure 5. the said hollow mould and solid tool will be in the same relative positions as they are represented in the section Figures 1 and 3 sheet II which has been already explained. The flat plate or Shelf of metal must be introduced horizontally endway into the press between the pillars V V thereof and when laid horizontally over the broad hollow of the said mould A A as already explained it

it is guided so as to lay correctly over the hollow by means of studs which are fastened at each edge of the hollow of the mould A A and project upwards suitably for receiving the two edges of the plate or Shelp of metal between them and if the plate should be too wide it will not go in between those steps and will be detected as being unfit for turning up but the plate should be of a proper width which will be shown by being wide enough to fill the space between the said studs without being loose between them. The plate being properly laid then the injecting Pump is set to work and by forcing water into all the three cylinders at once will raise up the three rams and three followers S T V and the hollow tool A A together with the plate or Shelp thereon until the said plate or so rising upwards is brought with its upper surface in contact with the under part of the solid upper tool B B which is immoveable and then what has been before described as a pressing of the plate begins though in fact in the mode now describing it is rather a prefsing up of the two margins of the plate by the ascending portion of the lower hollow tool A A whilst the middle part of the breadth of the plate is prevented from rising by the upper fixed tool B B but the effect is the same as already described in reference

to the aforesaid Figures 1 and 2 - Sheet 4 and need not be repeated except to state that the motion of the press is to be continued until the plate is completely bended and a great force of pressure should be ultimately exerted in order to insure that the bending is conveniently performed - Then the water is to be let out from any convenient part of the conveyance pipe by opening a cock in the usual manner of hydrostatic presses and the rams with the followers S T V and the long hollow tool A A will descend by their own weight and the bended plate or Shelp may be removed from the hollow of the mould by passing it endways out of the press between the pillars V V thereof and it will be one plate or Shelp bended to the first stage of the operation of turning up - After a number of such plates or Shelps have been treated in the same manner as aforesaid then the press may be prepared for performing the second stage of the operation of turning up by removing the upper solid tool B B from beneath the head R R of the press by withdrawing the screws by which it was suspended and fastened in place beneath the same and the other solid tool D Figure 2. Sheet 4 is to be substituted and suspended beneath the head R R by the said screws - After this preparation the further bending of the plates

plates or Sheets which have been
heretofore bended to the first
stage is to be performed by intro-
ducing those plates or Sheets one
at a time endways into the press
between the pillars V.V. thereof and
the press put in operation in the
manner above described for the pur-
pose of bending the middle part
of the breadth so as to turn up
the edges to the second stage as shewn
in Figure 2 Sheet 4 and already
explained - and after a number of
the plates or Sheets have been so
treated then the press may be pre-
-pared for performing the third stage
by removing the upper solid tool
D and substituting an upper hollow
tool such as appears at X in Figure
6 and hereinbefore described as hollow-
-ed with a semi cylindrical groove
for forming the upper half of a hollow
mould the corresponding semi cylindric-
-al groove E - Figure 3 Sheet 4 for
the lower half thereof being formed
at the bottom of the hollow of the mould
A A. and the press is worked as before
in order to compress the partly turned
up plates or Sheets between the said
two halves E and X as already
explained in reference to Figure 5 Sheet
5. for completing the turning up of
the plates or Sheets to their intended
tubular form - and note instead of
a semicylindrical groove E being formed
as aforesaid at the bottom of the
hollow of the mould A A. a distinct
mould

mould with such a groove may be
used for the lower half as shewn at
Y. Figure 6 and a like mould Z
with a corresponding groove for the
upper half so as that such two
halves Y Z when they come to gether
will form a complete hollow mould
which will be the same as to its
interior form and size and will
operate in the same manner as
the mould formed by the groove E
at the bottom of the mould A A and
the groove in the mould X in
Figure 6 but in case of so using
the pair of half moulds Y Z. the
mould A A must be removed from its
place on the three followers S T V
of the press and the lower half mould
Y. substituted when the press is to
be prepared for performing the
third stage of the operation the
upper half mould Z being at the
same time suspended from the head
R R. of the press instead of the half-
mould - and note in case of an
extensive manufacture of tubes there
may be three such presses as re-
-presented in Sheet 6 whereof one press
may perform turning up of the plates
or Sheets to the first stage with the
hollow mould A A and solid tool B
another press may continue the
turning up of the same tubes or
Sheets to the second stage with
the hollow mould A E. and Solid tool
D and the other press may be em-
-ployed for completing the turning up
of

of the intended tubular form either with the hollow half moulds A B and X and in that way the loss of time and trouble of changing the moulds and tools will be avoided and a great quantity of work performed - And note when plates or Skelps of shorter length than the full length of the hollow moulds are required to be turned up therein short pieces of one of the same plates or Skelps should be laid in the hollow of the mould at the two ends of the hollow beyond the two ends of the short plate or Skelps so as to serve for prolonging the short plate or Skelp to the full length of the hollow in order that all the length thereof may be filled up when the great pressure is given and therefore the said pressure will be operative in an uniform manner along all the length of the moulds in the same manner as if plates or Skelps of the full length were to be operated upon such short pieces when they have been once pressed into the form of the hollow may be retained and fastened thereon for continual use so long as short plates or Skelps are to be turned up. The plates or Skelps of metal which are to be turned up according to this second part of my improvements in the manner hereinbefore described must be correctly prepared in their width and their thickness to suit the exact size of the tube which the hollow moulds

moulds and tools are adapted to form by their operation as aforesaid and for so turning up for tubes of different sizes different hollow moulds and tools must be provided. The hollow moulds and tools may be made of wrought iron or of cast iron with their hollows and acting surfaces accurately formed by planing so as to be straight and true and parallel and also their exterior surfaces which are to apply beneath the head of the press R R and above the followers S T V should be planed true flat and parallel. The surface of these followers and of the head of the press to which the said exterior surfaces of the moulds and tools are to apply being also planed true the parts will fit correctly together to perform the turning up with accuracy. Care must be taken to keep the hollow of the moulds well cleaned out from dirt and scales which will be liable to separate from the surfaces of the plates or Skelps when they are in the act of being bended - and the plates or Skelps of metal which are to be turned up according to this second part of my improvements may be operated upon in a cold state the metal having been previously annealed in order that it may bend more easily or the metal may be slightly heated and operated upon whilst in the heated state if preferred although

although it will not be advisable to heat the metal so strongly as to occasion scales to be formed on its surfaces by the heating. The said mode of turning up according to this second part of my improvements is most applicable to tubes whereof the metal is thin in comparison to the interior diameter of the tubes such as the tubes which are used in the interiors of Steam Boilers for Locomotive Steam Engines and Steam Engines for Steam Navigation particularly the latter, such tubes require to be very truly formed and the edges well united and owing to the thinness of the metal whereof they are usually made, the bending can be performed for turning up in manner already explained when that metal is cold, and respecting the turning up of plates or Skelps which have been prepared with vee grooved and double bevilled edges according to the first part of my improvements hereinbefore described and with an increased thickness of metal along that edge which is vee grooved or the turning up of Skelps which have been prepared according to the said first part of my improvements by rabbeting the edges and so that the overlapping of the rabbeted edges will cause an increased thickness at the joint and in case of such increased thickness being intended to be

be at that side or surface of the plate or Skelp which will ultimately become the exterior surface of the tube all which has been hereinbefore described in reference to Figures x and y. Sheet V when the turning up of such plates or Skelps to a tubular form is to be performed by pressure within hollow moulds according to this second part of my improvements as hereinbefore described then the internal surfaces of the hollows of such moulds should be suitably cut away at those parts where such increased thickness will apply to and be pressed against the said interior surfaces in order that after the turning up the said thickened edge may be left slightly prominent beyond the correct outline that is proper for the exterior circumference of the tubular form which is produced by the turning up and such prominent part continuing along the longitudinal seam or joint all the length of the tube will allow for any loss of metal which may take place in the subsequent operation of heating and welding of the edges together and the prominence being hammered or pressed down in that operation or subsequently will render the joint very close. Or in case of soldering or brazing it may be thought desirable to have such a prominent part along the joint which

which may be subsequently hammered or prelled down if preferred and respecting the turning up of plates or shelfs of metal which have been prepared with bevilled or feather edges suitably for forming lapped or scarf joints such as Figure B Sheet I. and which mode of preparing shelfs with bevilled or feather edges is commonly practised and forms no part of my improvements The turning up of such bevilled or feather edged plates or shelfs to a tubular form may be performed by pressure within hollow moulds according to this second part of my improvements in the same manner as hereinbefore described except that the bending of the middle part of the breadth of the plate during the second stage of the operation by pressure with the upper solid tool D, Figure 2. Sheet IV should be no more than will be ultimately required without any of the overbending herein before mentioned - This will be effected by making the under part of the tool D of the same curvature as the interior of the intended tubular form to which the plate is to be turned up But in that case the bevilled edges of the plate will not remain in Contact one with the other after the turning up for when the metal is released from the pressure that is given at the conclusion of the third stage of the operation and withdrawn from the hollow moulds used in that

that third stage the metal will spring so as to separate the bevilled edges from the contact and open the joint - In such case the said edges may be afterwards brought into contact again and secured from separating by application of the third part of my Improvement hereinafter next to be described The third part of my said Improvements consists in a mode of fastening together the two edges of plates or shelfs which have been turned up to tubular forms For this purpose double dovetail pieces of metal called cramps are to be inserted or inlaid into corresponding double dovetail notches cut out in the two edges which are to be fastened together one such cramp being so inserted at every place along the length of the tube where such fastening is required see Figure 1 Sheet VII where a is one of the double dovetail pieces called cramps which is wider at each end and narrower at the middle - It may be cut out by suitable tools in a fly press from a flat plate of metal which is somewhat thicker than the thickness of the turned up plate or shelf into which the cramp is to be inlaid a great number of such cramps may be made by that mode with ease and rapidity and the cramps so cut will all be exactly of the same

same form and size. C Figure 2 represents two of the dovetail notches in the edges of the turned up plate or Shelf, they are exactly opposite one to the other so as to form a pair of dovetail notches which are adapted for receiving one of the cramps a. The two notches which constitute the pair of notches C may be cut out in both edges of the turned up plate or Shelf at once by suitable tools in a Fly press after the turning up to the intended tabular form has been performed. The pair of notches so cut out being exactly of a proper form and size to admit of inserting one of the cramps a, into the pair of notches but so as that the cramps so inserted will fill the pair of dovetail notches having no sensible vacancy and then by hammering or pressing on the surface of the clamp as it lays in its place in the notches and is supported on a suitable mandril in the turned up tube the cramp can be spread laterally so much as to fasten itself into the notches and also its thickness will become reduced to the same thickness as the metal of the turned up tube and the two surfaces of the cramp brought into exact conformity with the internal and external surfaces of the turned up tube. And such double dovetail cramps may be applied to plates or Shelfs which have been prepared for turning up and which have been turned up

up to a tubular form by any of the modes heretofore commonly known or practised for preparing and turning up of plates or Sheets of metal without the adoption of either of the first or second parts of my improvements. Because such cramps are equally applicable whether the edges of the turned up plate or Shelf form an edge to edge or butt joint along the length of the tube as shewn at Figure A Sheet 1. or whether those edges form a lapped or scarf joint as shewn at Figure B Sheet 1. and whether the two edges are in close contact or whether an open cleft is required to be left between the edges the said cramps within either case have the effect of securing the edges in their intended relative positions either in close contact or at their intended distance asunder as the case may be. and the edges which are so secured by the insertion of such cramps in manner aforesaid may be left without other means of union than the said cramps afford all the said edges may be united together by any of the usual modes of soldering or brazing or welding which latter in the case of the metal being wrought iron is to be preferred and the said will in either of those cases be very useful for retaining the two edges in their intended relative positions whilst the operation of soldering brazing or welding is performed and

and particularly so in the latter case because of the welding heat to which the iron must be subjected whereby it becomes softened and renders the edges of the turned up plate or Skelp without such cramps liable to become separated also in the case of welding the action of the hammering or of pressure between revolving grooved rollers or of the drawing through conical or bell mouthed apertures to one or other of which operations the heated and softened iron is subjected for effecting the welding renders the said edges in either case very liable to be displaced from their intended relative positions during the operation of welding. But such displacement will be prevented by the said cramps which will hold the two edges securely together in close contact during the heating and during the welding and the said cramps being themselves of wrought iron they will become welded into the iron of the welded tube so as to form one solid mass therewith to render such welding the more complete and the cramps should be cut out of plates of Iron of the same quality as that of the plates or Skelps into the edges of which they are to be inlaid and should be inlaid with the lengthway of the fibres of the iron disposed in the same direction in the cramp as

as is the case in the plate into which the cramp is inlaid - and in like manner in soldering or brazing the edges together the cramps become securely soldered or brazed into their places - and what I prefer is to use such cramps in the manufacture of metal tubes whereof the flat plates or Skelps have been prepared with vee grooves and double bevilled edges or with rabbeted edges accurately cut according to the first part of my Improvement already described and which plates or Skelps have then been turned up to a tubular form by pressure in moulds according to the second part of my improvements as hereinbefore described with the said edges fitting accurately one to the other with very close contact and in conformity with the other parts of the circumference of the tubular form and then by inserting cramps according to this third part of my said improvements the said edges will be effectually secured in the true intended relative positions which have been previously given to them - And note in case of plates or Skelps which have been prepared with bevilled or feather edges in the usual manner for making lapped joints as shewn at Figure B sheet 1. without any part of my improvements and which

which have then been turned up to a tubular form according to the second part of my improvements such turned up tubes are liable as already explained to spring open at the joint and separate the bevilled edges from close contact. In such case if this third part of my improvements is to be adapted the bevilled edges of the turned up tube must be brought into proper contact by any adequate means of compressing the exterior of the turned up tube previous to the inlaying and during the inlaying and fastening of the cramps into the said edges and the cramps so inlaid will secure the edges from separation. And note according to the degree of the said compression which is so given to the exterior of the turned up tube the bevilled or feathered edges may be forced together beyond their places of contact and thereby the joint or seam of the turned up tube will acquire an extra thickness with a prominence along the joint beyond the regular outline of the circumference of the turned up tube. This will be understood by inspection of figure 3 Sheet V where it is shewn how such prominence may be at the exterior surface of the turned up tube (or at the exterior surface of the turned up tube) or at the inner surface

surface thereof or at both exterior or interior surfaces or how the joint may be rendered even without any prominence as may be desired: and whichever of those states the joints may be brought into previous to and during the inlaying of cramps into the edges of the turned up sheets according to this third part of my Improvements those cramps will retain the edges securely in that state. And this third part of my improvement is particularly applicable in cases of plates or sheets which have been prepared with square edges suitably for butt or edge to edge joints as shewn at Seigure A Sheet I and which plates have then been turned up to a tubular form according to the second part of my improvements cramps inlaid into the edges of a turned up sheet of that kind will be very useful for fastening the edges together. The manner of cutting out the dovetailed notches in the edges of turned up tubes by tools in fly presses as hereinbefore mentioned for the reception of cramps according to this third part of my improvements is explained by Seigure 6 Sheet VIII which is a front elevation of a long work bench A A whereon two three or more ordinary screw fly presses (whereof one is shewn

shewn at B) are fixed in a row and at such distances apart as the cramps are intended to be inlaid into the edges of the tube And which will be most commonly one cramp near to each end and one cramp at the midlength of each tube unless the tube is very long or large and then more cramps may be inserted: but the said fly presses can be moved along the bench A and again fixed at the places required but all in a straight row and as many of them as may be required - One of the presses is shewn at B and the dotted lines C D denote the places for two other like presses - The upper moveable tool in each press (marked a) is a punch of the proper size and shape for cutting out a double dovetailed notch in the usual manner of fly press punches - but as to the bolster or lower hollow tool into which the said punch is to descend when it is forced down by turning the handle d of the screw e of the press in order to cut through the metal of the tube that is to be operated upon - The said hollow tool cannot be fixed in its usual and proper place on the base R of the press because it must go withinside of the tube - Therefore the said lower hollow tools for all the presses that are used are formed or are fixed in a long cylindrical

cylindrical iron bar E F that is of a size to admit the tube which is to be operated upon to pass easily over the bar - The said bar E F is kept truly to its intended place by an upright cylindrical bolt G which is sustained at its lower and upper ends by fitting truly through holes in a bracket H fitted to the bench A near to one end thereof; and the middle part of the bolt G passes through the enlargement or cross socket at the end F of the bar with exact fitting - The other end E of the bar is mounted in the same manner but with a smaller cylindrical bolt g which will not require any enlargement of the bar E F beyond its cylindrical form - The latter small bolt g is withdrawn when the tube which is to be operated upon is to be put into its place which is done by putting it endways over the bar E F as represented in section at i i. with the seam or longitudinal joint of the tube uppermost - Then the said small bolt g being inserted again the bar E F becomes secured in its proper place so that the several bolsters or hollow tools will be exactly beneath their respective punches a. in a proper manner for cutting out the double dovetailed notches in the edges of the tube i i. But as the Bar E F would spring downwards by the force of such cutting out it

it is necessary to support it firmly beneath each hollow Tool. For which purpose the underside of the cylindrical bar E F is notched or cut away to obtain a broad flat surface beneath each hollow tool which surface is inclined from the horizontal and a wedge piece is fitted beneath the said inclined surface so as to be capable of sliding endways along beneath that surface in the direction of the length of the bar E F. Part of the said wedge piece is formed to suit the curve of the interior of the Tube in and if the wedged piece is sliding along beneath the inclined surface of the bar E F towards the highest end of that surface then the wedge piece and the bar together will allow the tube to pass easily over them both for putting the tube into its place in the manner already explained. But after that is done the said wedge piece being slided along in a contrary direction or towards the lowest end of the said inclined surface then the wedge piece will quite fill the space beneath it within the tube i.i. and thereby enable the bar to receive a solid support within the tube when the lower side of the bar is lodged as shewn in Figure 3 in a suitable hollow at the base R of the press. Each of the said hollow tools is provided with such

such a wedge piece and in order to remove the several wedge pieces in manner aforesaid whilst they are inclosed within the tube, each one has a stem extending from it alongside of the bar E F or in a groove cut therein to near one or other of the ends thereof beyond the limits to which the ends of the tube extends towards the ends of the bar E F So that by pushing or pulling the said stems endways the several wedge pieces to which they belong respectively can be made fast within the interior of the tube as is requisite for enabling the hollow tools in the bar E F to resist the force of cutting out the double dovetailed notches in the tube by the forcing down of the punches &c. of the several presses through the metal of the tube and into the said hollow tools - which are beneath that metal within the interior of the tube. Or the several wedge pieces can by means of their said stems be set loose within the tube i.i. so as to allow the same to be removed from of the bar E F The hollow tools in the bar E F must be of steel welded or otherwise fastened to the upper side of the bar E F the upper surfaces of the Steel being formed to suit the curve of the interior of the tube and the hollow in each tool (which hollow is of the exact size and shape

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stems

shape of the punch a, or upper tool of the first) must be continued down into the substance of the bar E F in order to form a hollow space for the reception of the fragments of the metal of the tube which will be cut out therefrom in making the double dovetailed notches as the wedge piece will form a bottom to the said hollow space and prevent those fragments from falling through into the interior of the tube but after so many have been cut as to nearly fill up the said hollows with such fragments they must be removed and after the double dovetailed notches have been cut out in a tube in manner aforesaid by action of the several presses then a cramp is to be inserted into each of those notches to fill the same up. The previous to the bar E F is moved endways for a short distance within the tube i i (but without allowing any motion of the tube i i such as by the bellows) the several hollow tools in the bar E F are carried away from beneath the upper tools or plunches a of the several presses and solid parts of the steel surfaces of the hollow tools are brought beneath the said punches or upper tools a suitably for bearing up beneath the shorter cramps which are then to be inserted into the notches and then the lower ends of

of the upper tools a being forced down by action of the several presses upon the upper surfaces of the cramps so as to compress and expand the same laterally in order that they may become fastened into the notches wherein they have been inserted and in fact become inlaid into the substance of the metal of the tube. Note in order to allow the aforesaid endways motion of the bar E F to take place the base part of the bracket H should be fitted into a metal groove which is fastened to the bench A A so as to render the bracket H capable of sliding horizontally the requisite short distance for the aforesaid endways motion of the bar E F. And note in cases when from any cause the edges of the turned up plate or shelf are not in proper contact one with the other they ought to be then after the said turned up shelf has been put into its place (as at i i Figure 3 and as already described) some suitable piece of composition should be applied to the exterior circumference of the turned up shelf so as to bring the two edges thereof into their proper mutual state of contact and then (but not before) the double dovetailed notches should be cut out by action of the several presses in the manner already before explained and then the cramps inserted and

and fastened as already explained so as to retain the edges in their said intended state of contact before the force of compression is released. The requisite force of compression aforesaid may be given by thumb screws tapped through small pulpets in the base K of each press and pointing in horizontal direction towards the centre line of the tube and when a plate or Shelp of metal has been accurately prepared with vee grooves and double bevilled edges or else with rabbated edges according to the first part of my Improvements and then turned up by pressure in hollow moulds into a correct tubular form with those edges in close contact and in exact coincidence one with the other according to the second part of my improvements and then the said edges being secured from separating by means of double dovetailed cramps inlaid and fastened into corresponding notches in the said edges at suitable distances apart along the length of the tube according to the third part of my improvements the result will be very complete whether a tube so formed is to be left without any further uniting of its said edges than by means of the said cramps or whether those edges are to be further united by

by soldering brazing or welding and particularly so in the latter case because the said cramps will effectually retain the edges in their close contact and prevent them from separating while the Iron is in progress of being heated as well as after the Iron is become heated to its welding heat and consequently become much softened and whilst it is undergoing the operation of welding however that operation may be performed and those edges of the Iron plate or Shelp which are to be united together by the welding and also those edges of the iron cramps which are inlaid into the Iron of the plate or Shelp being all clean cut surfaces of Iron and being in close contact whilst the heating is going on no dirt or scale can gain admission because the said surfaces so as to hinder or impair the perfect welding thereof together and consequently the said welding will be very complete by formed with much less force of hammering or of pressure by rolling between revolving grooved rollers or by drawing through bell mouthed apertures than is usually required for effecting the welding of similar tubes which have been prepared in any of the modes heretofore known or practised for manufacturing tubes and especially