

(No Model.)

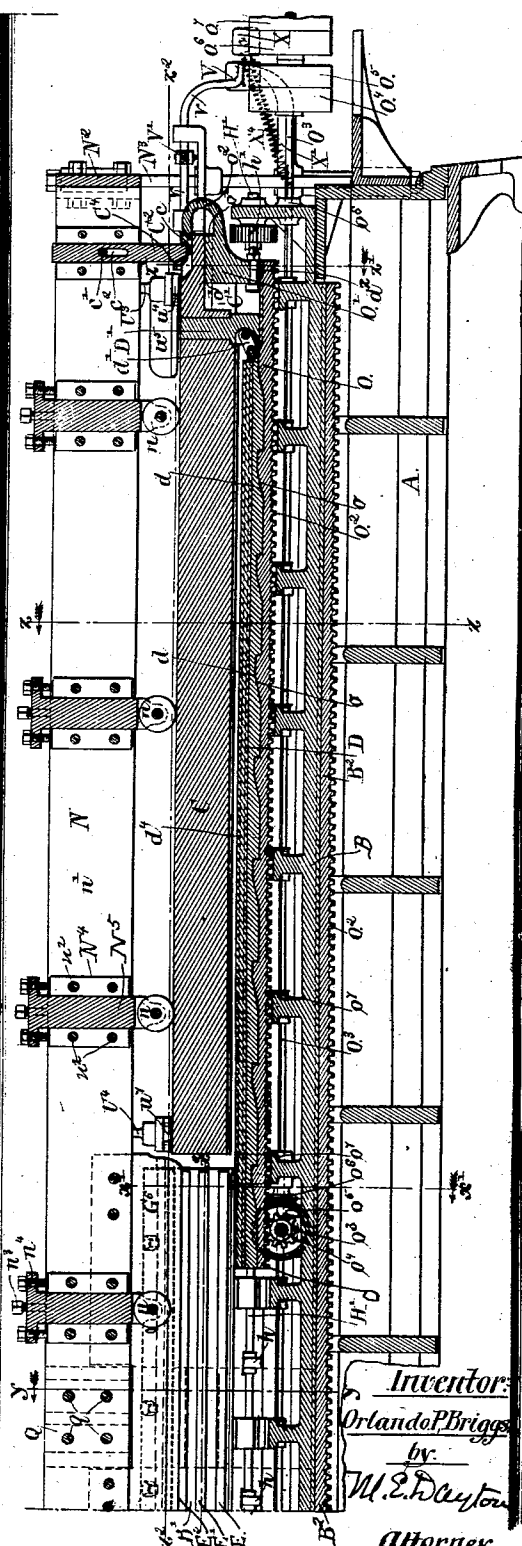
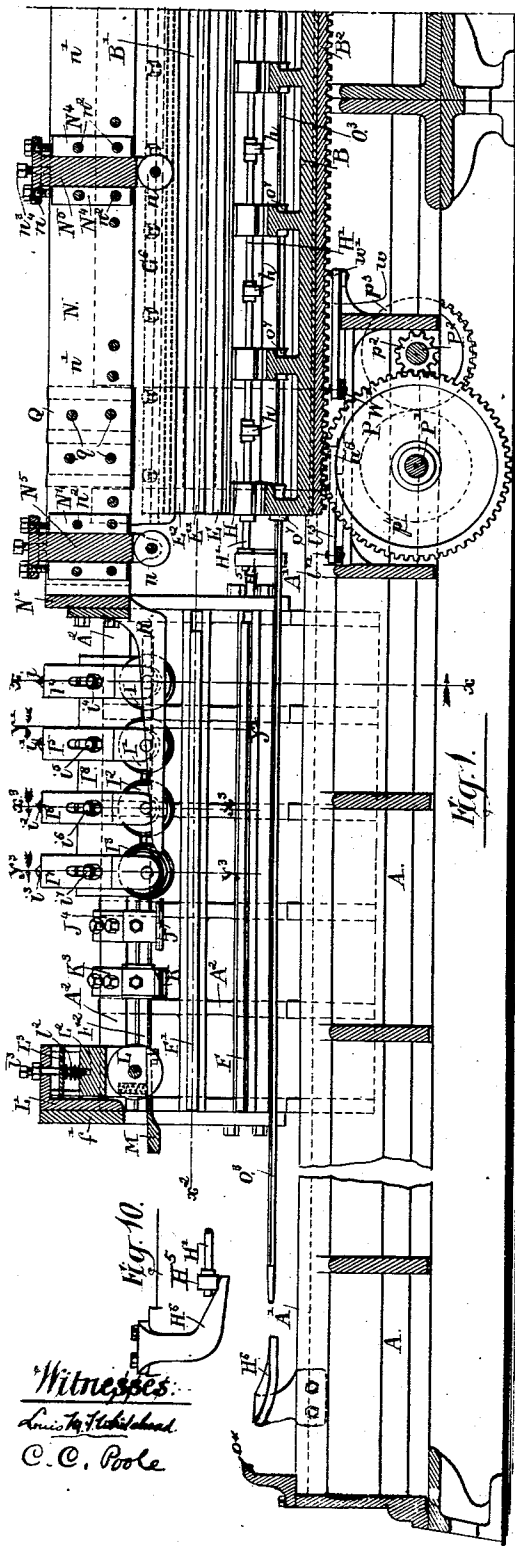
5 Sheets—Sheet 1.

O. P. BRIGGS.

MACHINE FOR MAKING CORRUGATED PIPE FROM SHEET METAL.

No. 430,266.

Patented June 17, 1890.



Witnesses:
Louis H. Kitchin
C. C. Poole

Inventor:
Orlando P. Briggs
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Attorney.

(No Model.)

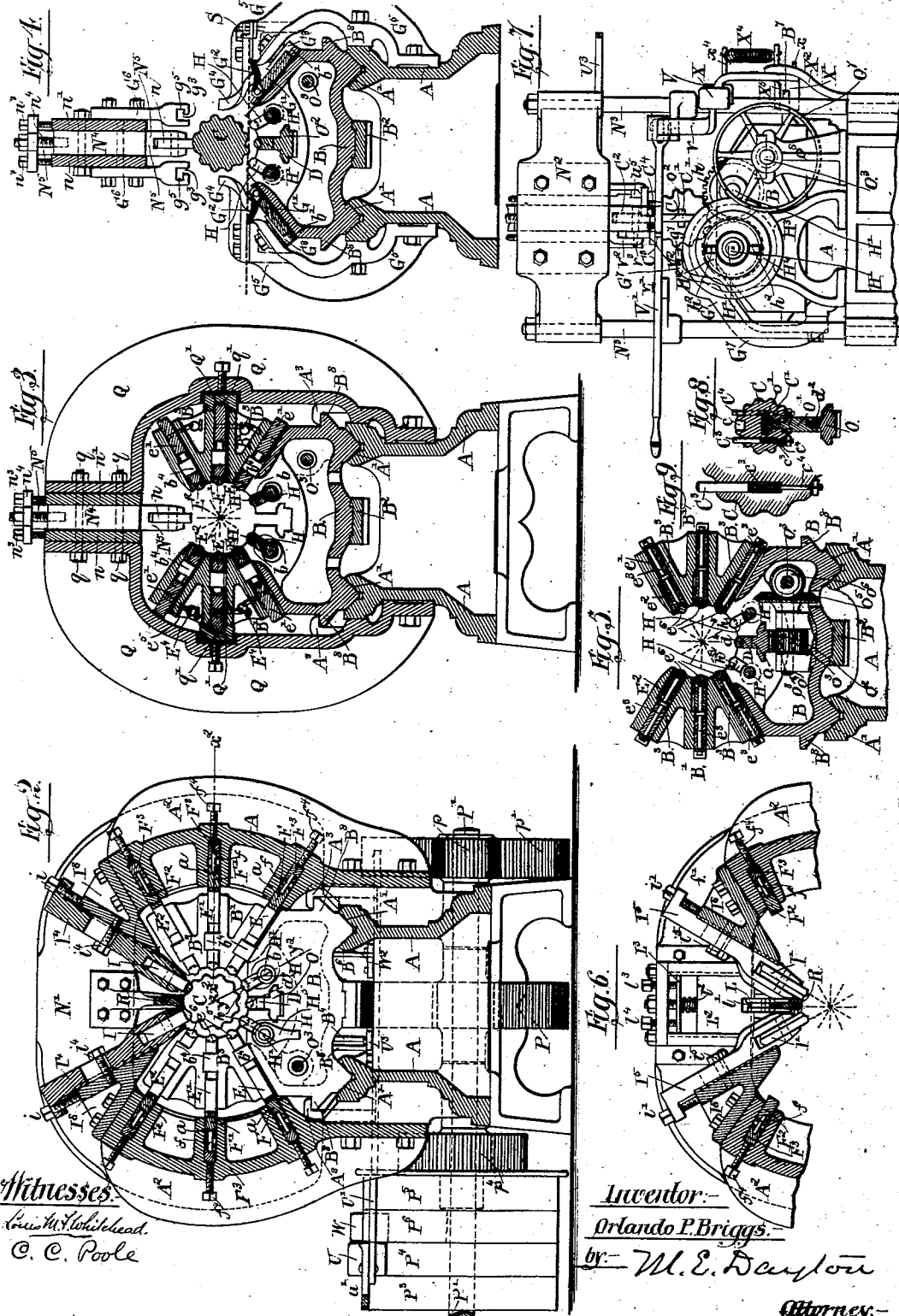
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5 Sheets—Sheet 3.

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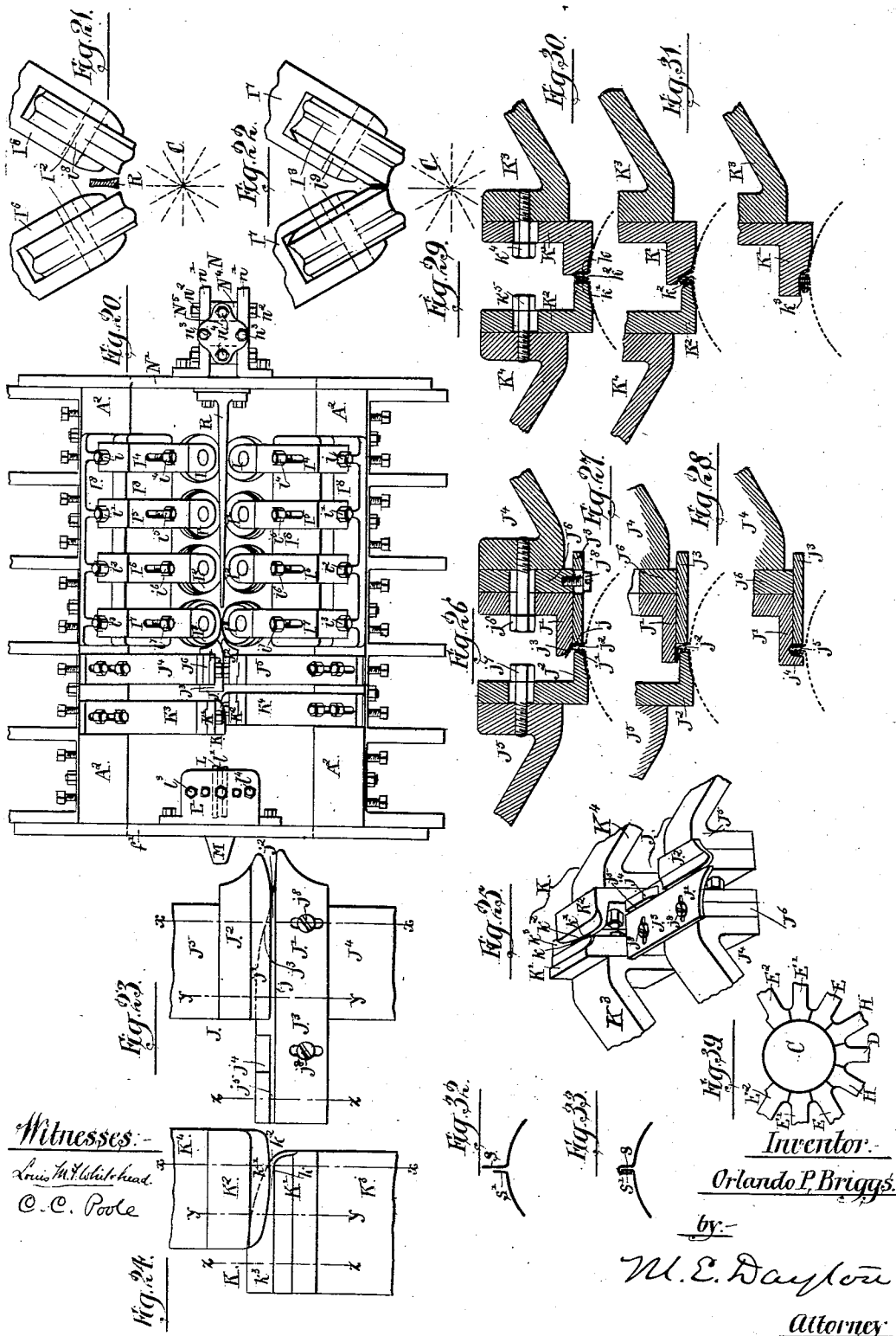
Patented June 17, 1890.

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5 Sheets—Sheet 4.

MACHINE FOR MAKING CORRUGATED PIPE FROM SHEET METAL.

Patented June 17, 1890.



(No Model.)

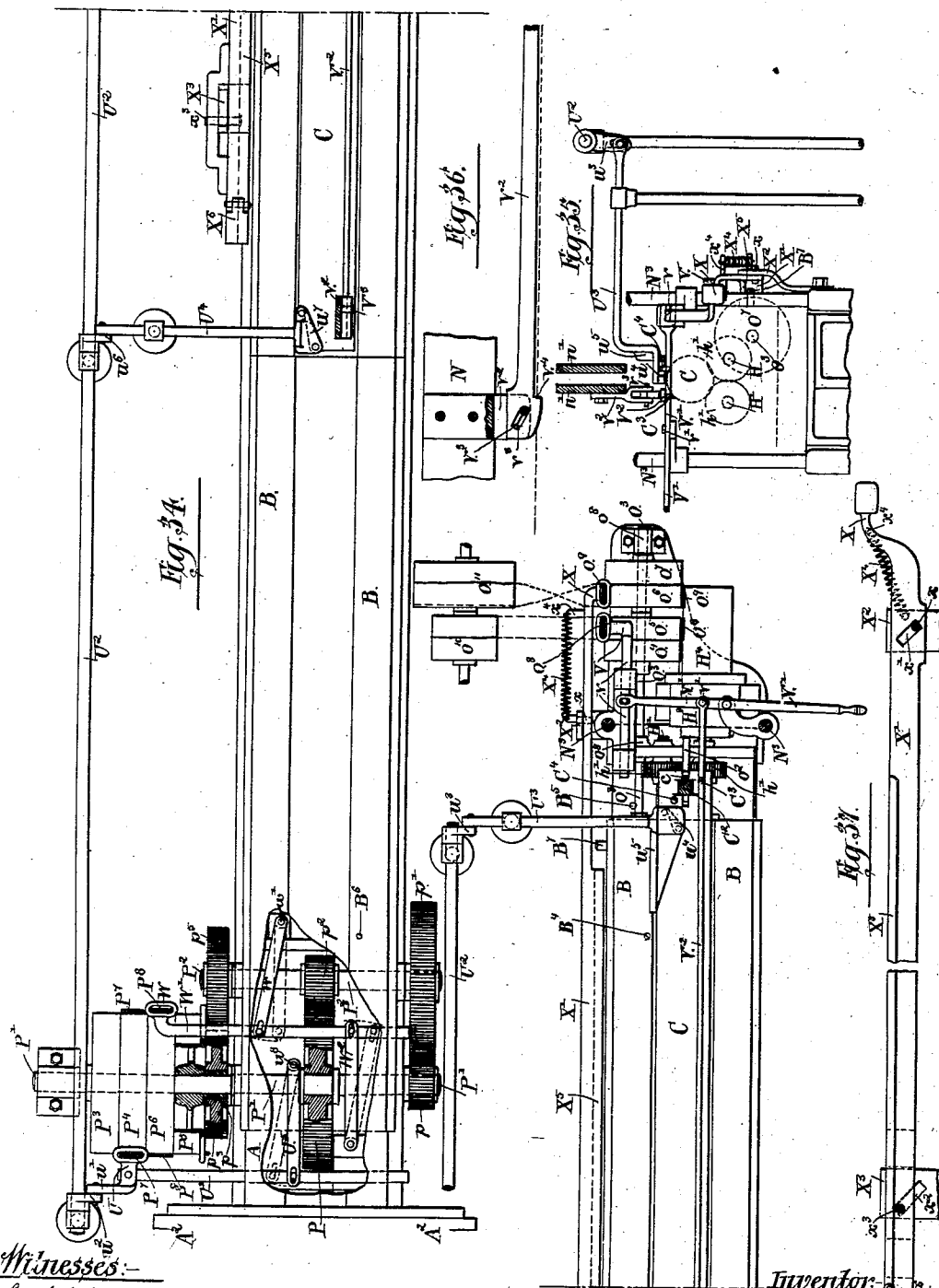
5 Sheets—Sheet 5.

O. P. BRIGGS.

MACHINE FOR MAKING CORRUGATED PIPE FROM SHEET METAL.

No. 430,266.

Patented June 17, 1890.



Witnesses:
Louis W. Whitehead.
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UNITED STATES PATENT OFFICE.

ORLANDO P. BRIGGS, OF CHICAGO, ILLINOIS, ASSIGNOR, BY DIRECT AND MESNE ASSIGNMENTS, TO JAMES A. MILLER AND ROBERT B. MILLER, OF SAME PLACE.

MACHINE FOR MAKING CORRUGATED PIPE FROM SHEET METAL.

SPECIFICATION forming part of Letters Patent No. 430,266, dated June 17, 1890.

Application filed November 9, 1885. Renewed December 11, 1889. Serial No. 333,302. (No model.)

To all whom it may concern:

Be it known that I, ORLANDO P. BRIGGS, of Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Machines for Making Corrugated Pipe from Sheet Metal; and I do hereby declare that the following is a full, clear, and exact description thereof, reference being had to the accompanying drawings, and to the letters of reference marked thereon, which form a part of this specification.

This invention relates to an improved machine for seaming and corrugating sheet-metal pipe or tubing; and it consists in the matters hereinafter described, and pointed out in the appended claims.

The machine herein illustrated as embodying my invention comprises as its essential feature a longitudinally-movable mandrel, devices for bending and clamping the sheet metal about the mandrel, and seaming devices consisting, essentially, of stationary seam-folders acting upon the marginal parts of the sheets to fold the latter together during the longitudinal movement of the mandrel.

The means herein shown for corrugating the tubing consists in a mandrel provided with a series of longitudinal grooves or corrugations and clamping-jaws provided with corresponding grooves or corrugations, whereby when the sheet-metal blank is clamped upon the mandrel it is bent into corrugated form, as will hereinafter fully appear.

In the accompanying drawings, illustrating my invention, Figure 1 is a central vertical longitudinal section of a machine embodying my invention. Fig. 2 is a transverse section thereof, taken upon line xx of Fig. 1. Fig. 3 is a similar section taken upon line yy of Fig. 1. Fig. 4 is a similar section taken upon line zz of Fig. 1. Fig. 5 is a detail transverse section taken upon line $x'x'$, Fig. 1. Fig. 6 is a detail transverse section taken upon line $y'y'$ of Fig. 1. Fig. 7 is a detail end view of the machine. Fig. 8 is a detail cross-sectional view taken upon line $z'z'$ of Fig. 1. Fig. 9 is an enlarged detail of a part of Fig. 8. Fig. 10 is a plan view of a cam-plate H^6 . Fig.

11 is a detail horizontal section taken upon line x^2x^2 of Figs. 1 and 2. Fig. 12 is a detail section taken upon line xx of Fig. 11. Fig. 13 is a detail longitudinal section taken upon line y^2y^2 of Fig. 2. Fig. 14 is a detail section of the parts shown in Fig. 13, taken upon line xx of said figure. Fig. 15 is a sectional plan view of the rear portion of the machine, taken upon line z^2z^2 of Fig. 1. Figs. 16 and 17 are detail sections taken upon line xx and yy , respectively, of Fig. 15. Fig. 18 is a detail cross-section taken upon line yy of Fig. 13. Fig. 19 is a detail plan section of a part shown in Fig. 13, taken upon line zz of said figure. Fig. 20 is a detail plan view of the seaming devices. Figs. 21 and 22 are detail views of seaming-rollers shown in Fig. 20, taken upon lines x^3x^3 , y^3y^3 , Fig. 1, respectively. Figs. 23 and 24 are elevations, and Fig. 25 a perspective view, of the seam-folders, viewed from beneath. Figs. 26, 27, and 28 are detail sectional views of the seam-folder shown in Fig. 23, taken upon lines xx , yy , and zz of said figure, respectively. Figs. 29, 30, and 31 are detail sectional views of the seam-folder shown in Fig. 24, taken upon lines xx , yy , and zz of said figure, respectively. Figs. 32 and 33 are sectional views illustrating the process of forming the seam. Fig. 34 is a plan view of the belt-shifting devices. Fig. 35 is an end view of the same. Figs. 36 and 37 are detail views of parts shown in Figs. 34 and 35. Fig. 38 is a detail sectional view upon line yy , Fig. 11. Fig. 39 is a detail view illustrating a circular form of mandrel.

In the machine illustrated in the drawings, A indicates the main frame or bed, which consists, principally, of two heavy plates or girders arranged parallel with each other and connected by suitable cross ties or girts, and B indicates a traveling bed or carriage sustained upon the frame A and constructed to slide in longitudinal grooves or ways A' upon said frame.

C is the mandrel, which is sustained upon the carriage B and is movable longitudinally thereof.

D is a vertically-movable clamp-bar located

beneath the mandrel and movable longitudinally with the latter.

E E' E² are a series of clamp-bars movable in radial planes obliquely toward and from the mandrel and mounted in supports or arms B', rigidly attached to the carriage B, and F F' F² are a series of gibs held in frames or castings A² upon the machine-frame, and constructed to encounter the ends of the clamp-bars in the forward movement of the carriage, so as to force the said clamp-bars rearwardly and inwardly, the inner edges of said gibs being located in position to engage the outer surfaces of the clamp-bars after the latter have been thrust inwardly, and to thereby hold said clamp-bars from outward movement while the seam is being formed. Said gibs are held between guide-surfaces α , formed in strong castings A², attached to the bed A at both sides of the path of the carriage.

G G are laterally-movable benders or folders located upon the carriage at either side of the mandrel for bending upwardly about the mandrel a flat sheet of metal or blank from which the tube is to be formed, so that the said blank may be carried with the mandrel between the clamping-bars E E' E² preparatory to the action of the latter thereon, and H H are clamp-bars mounted in the carriage B upon either side of the clamp-bar D and between said clamp-bar and the clamp-bars E E' E², for the purpose of forcing into contact with the mandrel the part of the metal between the clamp-bar D and said side clamp-bars E E' E².

I I' I² I³ are four sets of rollers adapted to press or clamp the blank against the portion of the mandrel above the clamp-bars E² and to bring the marginal parts of the said blank together over the mandrel.

J and K are stationary seam folders or benders operating to fold together the edges of the metal to form the seam, and L is a compressing-roller for pressing down the folded seam to form a tight joint.

The rollers I I' I² I³, the seam folders J and K, and the compressing-roller L are sustained upon the tops of the castings A² over the path of the mandrel and operate to form the seam during the longitudinal movement of the said mandrel in a manner hereinafter fully set forth.

The carriage B is somewhat longer than twice the length of the mandrel C, and the latter is movable longitudinally upon the carriage through a path of somewhat greater length than the said mandrel. The clamp-bar supports or arms B' B' are located at the forward portion of the carriage, (referring to its direction of motion while the tube is being formed,) and the said clamp-bars E E' E² and the supports B' B' are of approximately the same length as the mandrel, these parts being so arranged that the mandrel may be moved back upon the carriage until free from said supports to enable the flat blanks to be clamped thereon by the action of the clamp-bar D. The

castings A², by means of which the gibs F F' F² are supported, are located at the end of the machine-frame toward which the carriage moves in forming the tube, and in such position that when the carriage is at the rearward limit of its movement the clamp-bar supports B' will be free from said castings, the said clamp-bar supports being adapted in the forward movement of the carriage to freely pass between the said castings A², and thereby enable the clamp-bars to engage the gibs held in said castings.

The rollers I I' I² I³ are supported in suitable arms or brackets I⁴ I⁵ I⁶ I⁷, mounted upon the castings A² in position to operate successively upon the edges of the blank in the forward movement of the mandrel beneath them, the said rollers for this purpose being located at the portion of the castings A² adjacent to their rear end. The seaming-dies J and K are held in suitable brackets J⁴ K³, attached to the top of the said castings A² in advance of the forward roller I³, and the compressing-roller L is mounted in a frame L', sustained at the forward end of the castings A², so as to operate upon the seam as the mandrel emerges from between the said castings. The supports B' upon the carriage are located at the sides of the mandrel only, with sufficient space being left between the upper ends of said supports to enable them to pass the several seam-forming rollers described. The guides A' of the bed A are extended forwardly from the castings A² a sufficient distance to enable the carriage B to be advanced so as to carry the mandrel entirely past the said casting, so that the clamp-bars may be released from the gibs and allowed to expand to free the tube, and a suitable spring detent or stripper M is attached to the frame L' over the mandrel in position to engage the rear edge of the finished tube and to thereby hold the tube from backward movement with the mandrel, so as to strip said tube endwise from the latter.

The mandrel C is connected with and sustained upon the carriage B by means attached to the rear end of the mandrel only, thereby enabling the finished tube to be drawn freely from said mandrel over the forward unsupported end of the latter. In order to prevent the free end of the mandrel sustained in this manner from being lifted or thrust upwardly out of its place when the clamp-bar D is forced upwardly against it, a series of rollers n are located upon the machine-frame in position to rest upon the top of the mandrel during its longitudinal movement upon and with the carriage B until said mandrel comes beneath and is held down by the rollers I of the seaming devices.

As herein illustrated, the rollers n are supported by a longitudinal girder N, attached at its forward end to a heavy metal yoke N', bolted to the rear ends of the castings A² and secured at the rear end of the machine to a heavy cross-piece N², connected by means of vertical posts N³ with the bed A, Fig. 7.

The girder N may be made, in practice, in any manner suitable to give the necessary strength therein, said girder, as herein shown, being composed of two parallel plates n' , secured together by bolts n^2 , passing through blocks N^1 , which are located between the plates n' and afford bearings for vertically-adjustable bars N^5 , in the lower ends of which the rollers n are mounted. Said bars are held with the rollers in proper position for operation by means of set-screws n^3 , passing through lateral projections upon the bars and abutting against the girders and bolts n^5 , passing through lugs upon the bars and entering the blocks N^1 , whereby the vertical position of the rollers may be adjusted.

As a preferred means of supporting the mandrel upon the carriage B, a longitudinally-movable sliding support O is mounted in suitable guides in the said carriage below the mandrel, said support being provided at its rear end with a rigid standard O' , having sliding connection at its upper end with the mandrel. The clamp-bar D is supported upon the sliding mandrel-support O; said clamp-bar and support being provided upon their adjacent faces with a series of interfitting inclined faces d o , so arranged that when the support is moved longitudinally with reference to the clamp-bar the latter will be lifted into contact with the mandrel. The clamp-bar is connected with the mandrel by means permitting a vertical but not a longitudinal movement of said clamp-bar with reference to the mandrel, the means for this purpose herein shown as consisting of short links d' , pivotally connected with the rear end of the clamp-bar, and with a vertical bar or standard D' passing vertically through the mandrel and resting at its lower end upon the upper surface of the support O, said bar D' , together with the standard O' , serving to rigidly sustain the mandrel in a horizontal position. The sliding connection between the standard O' and the mandrel is formed by means of a T-head o' upon the standard O' engaging a correspondingly-shaped longitudinal recess C' in the mandrel, as clearly shown in Fig. 8. The mandrel is moved longitudinally upon the carriage by suitable actuating devices applied to the sliding support O, and the purpose of the sliding connection between the mandrel and the support O is to enable the latter to be moved a sufficient distance to actuate the clamp-bar D before the mandrel partakes of the forward movement of the said support, a detent C^2 , engaging the mandrel, being employed to hold the latter from movement with the support O until the clamp-bar has been forced upwardly into contact with the mandrel. The recess C' is made considerably longer than the standard O' , engaged therewith, and said standard is adapted to slide freely within the recess, so that the rack-bar may be carried forward a distance sufficient to lift the clamp-bar before the said standard O' engages the

forward end of the recess C' , and thereby causes a forward movement of the mandrel. To enable the relative movement of the rack-bar and mandrel to be adjusted as desired, a set screw or bolt d^2 is desirably inserted through the standard O' in position to bear at its inner end upon the bar D' .

In the particular construction of the parts herein illustrated the mandrel is provided in its upper surface with a notch c for engagement with the detent C^2 , and the latter consists of a sliding bar arranged to move vertically in a suitable bearing formed between the plates n' of the girder N, the downward movement of the detent being limited by a transverse rod c' , secured in the plates n' and passing through a vertical slot c^2 in the detent. The detent C^2 is lifted out of engagement with the notch c by means of a curved arm o^2 upon the standard O' , extending around the rear end of the mandrel and provided with an upper horizontal part having upon its forward end an inclined surface constructed to engage the lower surface of the detent, the upper portion of the arm o^2 being arranged below the level of the top of the mandrel and adapted to enter a groove or recess in the upper surface of the latter, whereby the rollers n may pass freely over the said arm o^2 in the forward movement of the mandrel.

As a preferred means for actuating the sliding support O, the said support is provided upon its lower surface with spur-teeth O^2 , which are engaged by a pinion o^3 upon a transverse shaft o^4 , mounted in suitable bearings in the carriage B, and provided with a beveled gear o^5 , engaging a beveled pinion o^6 , mounted upon a shaft O^3 , arranged longitudinally of the machine-frame, and having bearings o^7 in the said carriage and other bearings o^8 upon the bed A at the rear end of the machine, said shaft being provided with fast and loose pulleys O^4 O^5 O^6 O^7 , whereby a rotary motion is transmitted thereto by means of suitable driving-belts O^8 O^9 . In order that motion may be transmitted from the shaft O^3 to the shaft o^4 in all positions of the carriage upon the bed, the shaft O^3 is extended nearly the entire length of the bed and is made longitudinally movable in its bearings o^7 in the carriage, the beveled pinion o^6 being provided with a spline engaging a longitudinal groove in the shaft, whereby said wheel may slide longitudinally upon the shaft during the movements of the carriage. Said shaft, as herein illustrated, is unsupported from the frame and made conical at its forward end, so that when withdrawn from one or more of its bearings o^7 in the rearward movement of the carriage it will readily re-enter said bearings in the succeeding forward movement of the said carriage.

In order to release the clamp-bar D from the finished tube, a stop o^9 is provided at the forward end of the frame, adapted to encounter the support O shortly before the clamp-

bars $E E' E^2$ become disengaged from the gibs and to thereby hold said support from further forward movement with the mandrel, which latter is held by the clamp-bars from backward movement upon the carriage, the stop o^3 being preferably so located that the clamp-bars $E E' E^2$ will become disengaged from the gibs at the moment that the support O reaches the rearward limit of its movement relatively to the mandrel and after the clamp-bar D is fully retracted.

The folding devices shown for bending the side portions of the blank upwardly around the mandrel after it has been clamped upon the latter by the action of the clamp-bar D are constructed as follows: The folders $G G'$ are each formed of two parts, consisting of longitudinally-arranged plates G' , movable upon the sides of the carriage B in a direction radially toward and from the mandrel, and flaps G^2 , hinged to the upper edges of the plates G' in such manner that the said flaps may be swung upwardly, so as to bring their inner surfaces against the sides of the mandrel.

The devices herein shown for actuating the parts G' and G^2 of the folders are constructed as follows: The said plates G' are mounted to slide in an oblique direction upwardly and rearwardly upon the carriage B , said carriage for the purpose of supporting the plates being provided with T-shaped inclined projections or ribs b' , engaging correspondingly-shaped grooves g in the plates G' . The said plates G' are actuated by means of rollers G^3 , mounted in bearings rigidly attached to the main frame of the machine, said rollers being adapted to engage inclined surfaces g^2 upon the forward ends of the plates G' in such manner as that the said plates will be thrown upwardly and rearwardly, and thereby advanced toward the mandrel when the said inclined faces g^2 encounter the rollers in the forward movement of the carriage. The rollers are located in position to engage the outer or lower edges of the plates G' , so as to hold the latter from outward movement after they have been thrust inwardly by the said rollers, Fig. 17.

The flaps G^2 are swung upwardly or thrown toward the mandrel by the action of stationary upwardly and inwardly inclined cams G^4 , Figs. 15, 16, and 17, which are arranged to encounter and lift the flaps in the forward movement of the carriage in an obvious manner. In the particular construction herein illustrated the rollers G^3 are mounted in and the cams G^4 are formed upon heavy metal arms or brackets G^5 , bolted to the sides of the main frame A of the machine and overhanging the sides of the carriage B , as clearly shown in Fig. 4.

In the operation of the machine the carriage is moved forward for actuating the folding devices after the lower clamp-bar D has been lifted to clamp the blank of the mandrel and before the said mandrel begins its advance movement upon the carriage for

carrying the blank between the clamp-bars $E E' E^2$. In this advance movement of the mandrel the blank, being held upon the mandrel by the clamp-bar D , is obviously moved with the mandrel, and is thereby carried out of engagement with the flaps G^2 and into the space between the arms B' and in position for the action of the clamp-bars $E E' E^2$ thereon.

The rollers G^3 and cams G^4 obviously remain in engagement with the plates G' and flaps G^2 of the folders while the carriage is being moved forward to bring the clamp-bars $E E' E^2$ between the gibs $F F' F^2$; but in the advance of the carriage to carry the clamp-bars beyond the gibs the said plates G' and flaps G^2 will pass forward of the said rollers and cam-surfaces and become disengaged therefrom. In order to prevent the said flaps and plates from falling outwardly away from the mandrel at this time, longitudinal guide-plates G^6 are secured to the machine-frame over the flaps, said plates being provided with longitudinal grooves g^3 in their lower faces, constructed to engage projections g^4 upon the free edges of the flaps, so as to hold the said flaps from outward movement. Said groove and the projection g^4 , if found necessary, may be provided with lateral extensions $g^5 g^6$, making them of L shape, as clearly shown in Fig. 17, so as to positively hold the plates G' from downward movement.

To positively throw the plates G' and flaps G^2 outwardly or away from the mandrel, so as to bring them into position for the insertion of the flat blank after said plates and flaps have been carried past the rollers G^3 and cam-surfaces G^4 in the backward movement of the carriage, rigid arms G^7 , provided with forwardly-directed inclined projections g^7 , Figs. 7 and 15, are attached to the sides of the frame A in position to engage the rear ends of the said plates and flaps shortly before the carriage reaches the rearward limit of its movement, the projections g^7 being adapted to enter between the flaps and the mandrel and to engage the inner surfaces of the flaps, so as to throw the latter outwardly, and the arms being constructed to arrest the rearward movement of the plates, and thereby cause said plates to be moved outwardly by sliding upon the oblique guides b' .

The clamp-bars H are held and adapted to slide between guide-faces $b b$ in the carriage B and located in the forward part of said carriage beneath the clamp-bars E . As a convenient means for actuating the clamp-bars H , two longitudinally-arranged shafts H' are mounted in the carriage B below and radially in line with said clamp-bars, each of said shafts being provided with a series of eccentrics h , engaging the lower edges of the clamp-bars in such manner that when the shaft is given a half-rotation in one direction the clamp-bars will be advanced to engage the mandrel, and when turned to an equal extent in a reverse direction the clamp-bars will be

released and allowed to fall away from said mandrel. The shafts H' are provided at the rear end of the carriage with intermeshing gear-wheels h' , and one of said shafts is extended rearwardly beyond the carriage and is provided upon its rear end with two radial pins h^2 , engaging cam-grooves h^3 , formed in a stationary casting H^2 , said grooves h^3 being adapted to move the pins h^2 , so as to give a partial rotation to the shaft H' as the said pins are carried through them in the forward movement of the shaft and carriage and thereby cause the clamp-bars H to be forced toward the mandrel. The grooves h^3 are made straight and parallel with the shaft H' in their rear portions, so as to enable the pins h^2 to travel through them without turning the shaft while the carriage is being advanced to cause the operation of the folders G , and are made of curved or spiral form in their parts adjacent to the front end of the casting, the said spiral parts being located in position to give a partial rotation to the shaft and thereby cause the advance toward the mandrel of the clamp-bars H after the mandrel has been moved forward upon the carriage, and at the beginning of the forward movement of the latter to carry the clamp-bars $E E' E^2$ into engagement with the gibs $F F' F^2$. In the continued forward movement of the carriage, after the shafts have been rotated, as above set forth, the pins h^2 are carried forward out of the cam-grooves h^3 , the grooves preferably being arranged to give the shafts a half-rotation, so that the clamp bars H will be held in contact with the mandrel by the eccentrics unless the shaft is forcibly rotated to release them.

In the particular construction of the parts herein illustrated the tubular casting H^2 , in which the grooves h^3 are formed, is held by bolts or otherwise within a tube H^4 , rigidly secured in a cylindric opening formed in the upper part of a standard H^3 , attached to the rear end of the frame A . In order to give a backward turn to the eccentric-shafts H' , so as to release the clamps H at the forward limit of the movement of the carriage and permit the mandrel to be withdrawn from the finished tube, one of the said shafts is extended beyond the front end of the carriage B and is provided upon its forward end with a radial arm H^5 , constructed to engage a stationary cam-plate H^6 , Figs. 1 and 10, located at the forward end of the machine and arranged to give partial backward rotation to the shaft when encountered by the said arm. The arm H^5 and cam-plate H^6 are preferably arranged to give only about a one-quarter turn to the shaft, this being a sufficient movement thereof to release the clamps for the purpose stated. The pins h^2 will obviously leave the cam-grooves h^3 after the shaft has been turned to close the clamps in the forward movement of the carriage, and in order to bring the pins into position to re-enter the said grooves in the backward move-

ment of the carriage after the shaft has been turned partially backward by the action of the arm H^5 and cam-plate H^6 , as above described, the side walls of the grooves are cut away at their forward ends, as indicated at h^4 , Figs. 13 and 19, in such manner as to form inclined faces adapted to engage the pins and to partially turn the shafts for the purpose above stated.

The means herein shown, Figs. 1 and 34, for moving the carriage longitudinally upon the frame A consists of a heavy rack-bar B^2 , secured to the lower surface of the carriage between the guides A' of the frame, said rack-bar being engaged by a spur-wheel P , mounted to rotate freely upon a transverse shaft P' , having upon one of its ends outside of the frame a pinion p , intermeshing with a spur-wheel p' upon a shaft P^2 , having upon it a pinion p^3 , intermeshing with the said spur-wheel P . The shaft P' is also provided with a pulley P^3 , rigidly secured to the shaft, over which passes the belt P^7 , for actuating the said shaft in driving the carriage forward, and with a loose pulley P^4 , to which the said belt may be shifted when the carriage is stopped. Said shaft is also provided with a second set of pulleys $P^5 P^6$ for the belt P^8 , by which reverse motion is given thereto for moving the carriage backwardly.

The gearing described is so proportioned as to drive the carriage forward with great power and at relatively slow rate of speed. To provide for a quick return or backward motion of the carriage, the pulley P^5 , through the medium of which the power for giving a backward movement to the carriage is transmitted thereto, is, instead of being secured directly to the shaft P' , mounted upon a sleeve p^3 , which rotates freely upon the shaft, and upon the said sleeve is rigidly secured a spur-wheel p^4 , intermeshing with a spur-wheel p^5 upon the shaft P^2 , the wheels p^4 and p^5 being made of about the same size, so that the motion of the pulley P^5 will be transmitted directly to the shaft P^2 without any loss of speed.

The several clamp-bars $E E' E^2$, as more clearly shown in Figs. 3 and 11, are made to slide between parallel guide-surfaces b^2 , formed in the arms or castings B' , and are held in place between said guide-faces by means of blocks or studs b^3 , rigidly secured in the said casting and passing through inclined slots e in the clamp-bars, the said slots being inclined in such manner that when the clamp-bars are thrust rearwardly they will also be carried inwardly into contact with the mandrel. The said clamp-bars in the particular construction illustrated are formed in two parts $e' e^2$, united by set-screws e^3 , threaded upon their inner ends to engage correspondingly-threaded apertures in the inner parts e^2 of the clamp-bars and passing through the outer parts e' of said bars, said set-screws being provided with collars at either side of the parts e' to hold them from end movement

therein, and having upon their outer ends heads adapted for engagement with a wrench, whereby said bolts may be rotated and the distance between said parts thereby adjusted to give a greater or less pressure upon the blank, as desired.

In order to relieve the bolts e^3 of transverse strain when the clamp-bars are moved bodily by the contact of the parts e' thereof with the gibs $F F' F^2$, the parts e' and e^2 are provided with interlocking recesses and projections $e^3 e^4$, having parallel side faces arranged transversely to the sides of the bars, so as to positively hold the said parts e' and e^2 from relative longitudinal movement. The said parts $e' e^2$ also are cut away at their adjacent edges between the bolts e^3 , as clearly shown in Fig. 11, and in the spaces thus formed are located posts b^4 , which serve to rigidly unite the wedge-shaped parts B^3 composing the said arms, and upon which the guide-surfaces b^2 are formed.

The clamp-bars, consisting of the connected parts $e' e^2$, are held at the forward limit of their movement, so as to stand normally free from the mandrel, by means of spiral springs E^4 , connected with the parts e' of the clamp-bars and with the frame B' . These springs may be arranged in any suitable manner; but in the particular construction illustrated they are located within recesses formed in the castings B^3 , Fig. 38, and are connected at one end with lugs b^5 upon the frame and at their opposite ends with studs e^5 , secured in the said clamp-bars and passing through slots b^6 in the parts B^3 . The lower guide-surfaces b^2 of the arms B' are preferably provided with transversely-arranged projections or ribs b^7 , Figs. 11 and 38, upon which the clamp-bars $E E' E^2$ rest and slide, the surface between said ribs being depressed, so as to leave spaces beneath the clamp-bars for the free exit of scale which may be detached from the iron in bending it.

The machine shown is adapted for making pipe of different sizes or diameters by inserting mandrels of greater or less diameter and by providing the clamp-bars at their inner edges with removable strips $d^4 h^5 e^6$, Fig. 5, varying in width to correspond with the sizes of the mandrels employed. When the machine is adapted for making corrugated pipe and the mandrel is provided with corrugations or grooves corresponding in number and location with the clamps, as herein shown, the number of corrugations or grooves will obviously be the same whatever the diameter of the pipe made.

The parts e' of the clamp-bars are, as clearly shown in Figs. 2, 3, 5, and 11, constructed to extend outwardly beyond the arms B' , so as to engage the gibs $F F' F^2$, the parts being relatively so arranged that when the forward ends of the said parts e' of the clamp-bars encounter the rear ends of the gibs the clamp-bars will be thrust bodily backward and will thereby be moved inwardly and

caused to engage the mandrel. The said gibs are so located also that when the clamp-bars have been thrust inwardly, as above set forth, the inner surface of the gibs will come in alignment with the outer edges of the clamp-bars, so that the latter may pass between the gibs, and will be held thereby positively from outward movement. The said gibs $F F' F^2$ are connected with the castings A^2 by means of a series of short pivoted links f , and a stop f' is provided at the forward end of the gibs to limit their forward movement, the stop being so arranged that when the gibs are in contact with the stop the links will be inclined forwardly, thereby sustaining the gibs unyieldingly from outward movement, but enabling the gibs to be moved outwardly if thrust bodily backward by pressure applied at their forward ends. The said gibs are held normally at the forward limit of their movement by springs f^2 suitably applied for the purpose, said springs, as herein shown, being placed about sliding rods f^3 , provided with laterally-extending heads at their inner ends adapted to bear against the sides of the links f nearest the ends of the gibs, as clearly shown in Fig. 11. The object of the construction described in the means for supporting the gibs is to enable the latter to yield outwardly to allow the movement past them of the clamp-bars $E E' E^2$ in the backward movement of the carriage after said clamp-bars have been advanced beyond the gibs to allow the release of the finished tube, it being entirely obvious that when the rear ends of said clamp-bars encounter the forward ends of the gibs in the rearward movement of the carriage said gibs will be thrust backwardly and outwardly for the purpose stated.

In order to enable the gibs to be moved inwardly and outwardly for adjusting them, as may be found necessary or desirable, the links f , instead of being pivoted directly to the castings A^2 , are connected with bars F^3 , held in castings by bolts f^4 , set-screws f^5 being inserted through the casting and arranged to bear against the bars F^3 , whereby the latter may be moved and held in their changed positions.

When the clamp-bars $E E' E^3$ are thrust endwise by the contact with the gibs $F F' F^2$, the outward strain caused by the pressure of the said clamp-bars upon the mandrel will obviously be transmitted to the arms B' through the studs b^3 , this strain obviously tending to force said arms apart at their upper ends. In order to relieve this strain upon the arms and to hold all the parts rigidly to their work, massive arms Q are bolted to the bed A at their lower ends and are secured together and to the girder N by means of bolts q , inserted through the said arms and girder, the said frames being provided upon their inner faces with gibs Q' , having bearing-surfaces q' resting against the frames B' both above and below the clamp-bars E' .

The rear ends of the gibs $F F' F^2$, which are engaged by the clamp-bars, are preferably located one in advance of the other, as clearly shown in Fig. 1, so that said clamp-bars will be successively closed upon the mandrel in the forward movement of the carriage. When the machine is adapted for making corrugated pipe, the several clamp-bars $H, E, E',$ and E^2 , beginning with the bar most remote from the free edge of the sheet, will be actuated in succession, thereby enabling the metal of the blank to be forced into the grooves of the mandrel without stretching it.

The rollers $I I' I^2 I^3$ are made adjustable radially toward and from the mandrel by means of adjustable connections uniting the brackets $I^4 I^5 I^6 I^7$ with castings or plates I^8 , which are bolted to the tops of the castings A^2 for supporting said brackets. Said adjustable connections are formed, as herein shown, by means of set-screws $i i' i^2 i^3$, passing through outwardly-projecting lugs upon the said brackets and engaging the upper surfaces of the plates I^8 , and bolts $i^4 i^5 i^6 i^7$, passing through slots in the said brackets and entering threaded apertures in the castings I^8 , the set-screws being employed to force the rollers toward the mandrel and the bolts to hold the brackets firmly in place. The rollers I , operating first upon the metal, are provided with approximately-cylindric or slightly-concave working-faces adapted to bend inwardly toward each other the free edges of the metal above the upper clamp-bars $E^2 E^2$, as clearly shown in Fig. 2. The second pair of rollers I' , Fig. 6, are provided with projecting parts or beads entering the grooves in the adjacent surface of the mandrel and adapted to force the metal closely into the said grooves. The third pair of rollers I^2 (shown in detail in Fig. 21) are provided at their adjacent faces with parts i^2 , adapted to bring the edges of the sheet metal more nearly together and to force the metal into contact with the mandrel near the line of the joint, and the fourth set of rollers I^3 , Fig. 22, are provided with beveled surfaces i^3 , which are parallel with each other in their parts adjacent to the mandrel, so as to bring the marginal portions of the sheet metal together and in position for the operation of the seam-folders J and K thereon.

R is a wedge-shaped guide rigidly secured over the mandrel between the rollers $I I' I^2$, with its pointed forward end between the rollers I^2 and I^3 , said guide serving to bend the marginal parts of the metal sheet upwardly or outwardly as the sheet is closed by the rollers against the upper surface of the mandrel and to thereby bring the said marginal parts of the sheet at right angles with the top surface of the mandrel, so that when the edges of the sheet reach the fourth pair of rollers I^3 they may be readily brought together thereby in a vertical plane.

It will be understood, of course, that a device for bending the metal preparatory to the

operation of the seam-folders, comprising a wedge-shaped guide and a series of rollers, may comprise a greater or less number of rollers than are present in the machine herein shown.

The side edges of the metal blank are so arranged with reference to the mandrel in clamping it upon the latter that when the said blank is folded about the mandrel and its edges are brought together, as above set forth, one of its edges, as indicated at s , Fig. 32, will stand considerably above the other edge s' , this relative position of the edges being determined by means of a stop or gage S , Fig. 4, located upon the frame in position to engage one edge of the flat blank when the latter is placed beneath the mandrel, as clearly shown in Fig. 4.

The seam-folder J (more clearly shown in Figs. 23 and 25) is so shaped as to turn the marginal part s of the sheet, extending above the shorter marginal part s' , over the latter into the position indicated in Fig. 33. Said folder for this purpose comprises opposing parts $J' J^2$, having adjacent vertical faces $j j'$, forming a vertical slot j^2 , constructed to guide and sustain the marginal parts of both sheets, the part J' having a surface j^3 , (more clearly shown in the detail sectional view, Fig. 26,) adapted to engage and bend laterally the marginal part s of the sheet, so as to bring the said marginal part into a horizontal position, as clearly shown in Fig. 27. The part J^2 extends about one-half the length of the part J' , and the forward portion of the said part J' is formed with an inclined surface j^4 , operating to bend the horizontally-turned edge s downwardly after it leaves the part J^2 , and terminating in a groove j^5 , operating to close said part s upon the part s' when it leaves the said folder J , as clearly shown in Fig. 28. The folder K is for the purpose of turning the parts folded by the folder J downwardly, so that they will rest flat upon the adjacent portion of the metal, and for this purpose said folder consists of two parts $K' K^2$, having opposing vertical faces $k k'$, forming between them a passage k^2 , Fig. 29, which is curved or deflected laterally, as more clearly shown in Fig. 30, to bend the said folded parts downwardly toward the mandrel, the part K^2 of the folder being terminated short of the forward end of the part K' , which latter is provided near its forward end with a surface k^3 , forming a continuation of the top wall of the groove k^2 and arranged to bend or press the folded parts of the metal closely to the adjacent parts of the blank, as clearly shown in Fig. 31.

The lower surfaces of the part J^2 of the folder J and of both of the parts of the folder K are preferably made to rest upon the portions of the blank adjacent to the seam, so as to hold said portions firmly in place while the marginal parts are being bent by the action of the said folders, as clearly shown in Figs. 26 to 31, above referred to.

The part J' of the folder J is preferably provided with a separate part or plate J³, the edge of which forms one of the side walls j of the groove j², and which is adjustable horizontally upon the upper portion of the said part J' to enable the width of the groove j² to be changed in working upon different kinds or thicknesses of metal. To enable the folders to be adjusted vertically in the use of mandrels of different sizes and under other circumstances, the parts J' and J² are made adjustable vertically upon the arms J⁴ and J⁵, the devices for attaching them to the arms for this purpose consisting of screws or bolts j⁶ j⁷, inserted through vertical shanks upon the folders, the bolt-apertures being elongated vertically in a familiar manner to admit of the required movement of the parts in adjusting them. In the particular construction illustrated the plate J³ is secured by screws j⁸, passing through slots in the plate, to a vertical piece or bar J⁶, made separate from the part J' and placed between the arm J⁵ and the said part J' by the bolt j⁶ holding the latter, this construction obviously allowing a vertical as well as a horizontal adjustment of the plate J³.

The parts K' K² of the folder K are adjustably connected with the arms K³ K⁴ by means of bolts k⁴ k⁵, inserted through slots in the vertical shanks of the said parts K' K² in the same manner as before described in connection with the parts of the folder J.

To give further bodily adjustment to the parts J' J² and K' K² of the folders J and K relatively to the mandrel, the arms J⁴ J⁵ and K³ K⁴, sustaining said parts, are attached to the castings A² by means of bolts passing through slots in the arms, whereby the latter may be moved laterally, as clearly shown in the plan view of the parts, Fig. 20.

The compressing-roller L is provided about its periphery with a shallow groove l', and is so shaped as to press the seam and the metal at either side of it firmly and closely down upon the mandrel, and to thereby form a tight joint. In the particular construction of the parts herein illustrated the said roller is mounted in a vertically-movable block L², held in suitable guides in the frame L', the roller being held down to its work by springs, as l², located between the top surface of the block L² and a follower L³, which is held in position by set-screws and bolts l³ l⁴, whereby the follower may be adjusted vertically to vary the pressure of the spring in a familiar manner.

It will be observed that the several devices for forming the seam are arranged in position to operate upon the sheet metal when the clamp-bars E E' E² are engaged by the gibs F F' F², so that the seam is formed at a time when the sheet metal is held at all points closely and firmly in contact with the mandrel, thereby making the tube accurate in form and making all tubes of the same size,

notwithstanding variations in the quality or characteristics of the metal.

After the seaming has been completed by the operation of the seaming devices described the motion of the carriage is continued, as before stated, until the arms B' thereon and the clamp-bars E E' E² are free from the gibs, when the tube is released and becomes engaged at its inner end with the spring-detent M, whereby in the backward movement of the carriage the tube is stripped from the mandrel.

The driving-shafts P' and O³, by which the mandrel-support O and the carriage are actuated, may be started, stopped, and reversed, so as to give the desired relative-movement to the several parts, by any suitable mechanism, actuated either by hand or by the movement of the machine. A preferred construction in devices for this purpose, whereby the several movements will take place automatically in the proper order, and in which said movements are accomplished by belt-shifting devices, is herein shown, and is as follows:

U is a belt-shifter engaging the belt P⁷, which passes over the fast and loose pulleys P³ P⁴ of the main transverse driving-shaft P', and V is a belt-shifter engaging the belt O³, which passes over the fast and loose pulleys O⁴ O⁵ upon the shaft O³. The belt-shifter V is supported by a horizontally-sliding bar v, which is actuated by means of a pivoted hand-lever V', said parts being mounted upon suitable supports attached to the posts N³, as clearly shown in the drawings, Figs. 34 and 35.

V² is a longitudinally-arranged bar or rod located over the mandrel, with its rear end connected with the lever V' at a point v' between its axis, and its end engaged with the bar v and sustained from the girder N at its forward end by means of bars or plates v², having at their lower-ends upwardly and forwardly inclined slots v³, engaged by a pin V³ in the forward end of the rod V². The said rod V² is provided also upon its lower surface near its forward end with a projection v⁴, having a vertical face adapted to engage a stop or pin C³, located upon the mandrel near the rear end thereof, these parts being so constructed that when the pin C³ engages the face v⁴ in the forward movement of the mandrel the rod V² will be carried forward, and will, when moved a sufficient distance to cause the shifting of the belt, be lifted by the movement of the pin V³ in the slots v³, so as to cause the disengagement of the said pin from the said surface v⁴.

The bolt-shifter U is attached to a bar U', mounted to slide transversely in the frame of the machine, and said shifter is connected also with a rock-shaft U² by means of a depending arm u² upon the said shaft engaging an arm u' upon the belt-shifter. The rock-shaft U² is arranged parallel with the machine-frame and extends from said belt-

shifter U to a point near the rear end of the frame, said rock-shaft being connected by means of a depending arm w^3 with the horizontal sliding bar U^3 , extending inwardly to a point over the mandrel, and provided upon its end with a horizontal swinging spring-pawl w^4 , located in position to engage a stop C^4 upon the mandrel in such manner that in the beginning of the forward movement of said mandrel the pin C^4 will engage the pawl w^4 , and thereby throw the bar U^3 outwardly, said pawl w^4 being adapted to yield to permit the passage of the pin in the backward movement of the mandrel without producing any movement in the said rod or the rock-shaft. The stop C^4 is arranged a short distance from the pawl w^4 , so that when the shaft O^3 is started by the movement of the hand-lever V' and the support O is moved forward, as before described, the stop C^4 will, as soon as the mandrel begins to move, engage the said pawl w^4 , and thereby thrust the bar U^3 outwardly and move the rock-shaft, so as to shift the belt from the loose pulley P^4 to the fast pulley P^3 , and thereby start the carriage. This movement of the carriage continues until the sliding plates G' and the flaps G^2 of the folders engage the rollers G^3 and cam-surfaces G^4 , and said folder is thrown inwardly and upwardly thereby. In order to stop the carriage when the folding is accomplished, to enable the mandrel to be carried forward upon the carriage by the action of the shaft O^3 , the bar U^3 is provided at its inner end with a laterally or forwardly projecting part w^5 , adapted for engagement with the rear end of the flap G^2 of the folder in such manner that when the said flap reaches the inward or upward limit of its movement the said bar U^3 will be drawn inwardly, and the belt thereby shifted from the fast to the loose pulley. This having been accomplished, the continued movement of the shaft O^3 will carry the mandrel C forward until it is fully within or between the arms B' B' , when the stop C^3 , striking the projection v^4 of the rod V^2 , will carry the said rod endwise, thereby moving the belt-shifter V and shifting the belt O^8 from the fast to the loose pulley of the shaft O^3 , so as to stop the movement of the mandrel. To again shift the belt from the loose pulley P^4 to the fast pulley P^3 , so as to start the carriage forward to actuate the clamp-bars E E' E^2 , a bar U^4 is provided, which is connected with a depending arm w^6 upon the shaft U^2 , and which has upon its inner end a spring-pawl w^7 , arranged in an inclined position in the path of the pin C^4 in the same manner as is the pawl w^4 , before described, so that when the said pin C^4 strikes the said pawl w^7 the bar U^4 will be thrust outwardly, and the shaft U^2 thereby turned to move the shifter in the manner before described. After the pin C^4 has moved past the pawl w^7 the movement of the carriage will continue until the forward limit of its movement is reached, when suitable devices for reversing the direc-

tion of movement of the said carriage will come into operation, as hereinafter described.

The pins C^3 and C^4 are, as shown, located in the top surface of the mandrel, and, in order to prevent interference of the said pins with the rollers I I' I^2 I^3 when the mandrel passes beneath said rollers in its movement forward from between the castings A^2 for the release of the clamp-bars from the tube, said pins are made to slide in the mandrel and are sustained in operative position by springs c^3 , Figs. 8 and 9, so that they may be forced downwardly by the said rollers when they come in contact with the latter, and will resume their operative position when released from said rollers. In the particular construction of the pins illustrated, Fig. 9, the said pins are provided with axial prolongations c^4 , extending through the lower surface of the mandrel, and provided with nuts or heads to limit the upward movement of the pins, the springs c^3 being of spiral form and placed about the said prolongations c^4 between the lower ends of the pins and opposing shoulders in the mandrel.

To move the belt-shifter U, so as to shift the belt P^7 from the fast pulley P^3 to the loose pulley P^4 at the forward termination of the movement of the carriage, the bar U' , which, as before stated, is arranged to slide transversely in bearings in the bed A, is pivotally connected with a bar or link U^5 , arranged generally parallel with the sides of the frame and pivoted at u^8 to the latter, said bar being arranged for engagement with a pin B^4 upon the lower surface of the carriage in such manner that the said pin, by encountering the said bar U^5 , will thrust the said bar laterally, and thereby move the bar U' in a direction to carry the belt from the said pulley P^3 to the pulley P^4 . For reversing the direction of rotation of the shaft P' , so as to drive the carriage backward after it has reached the forward limit of its movement, a belt-shifter W is provided for shifting the belt P^8 from the loose pulley P^6 , upon which said belt runs in the forward movement of the carriage, to the pulley P^5 , which actuates the gears p^4 p^5 , driving the carriage backward. The said belt-shifter W is mounted upon the end of a horizontal transversely arranged bar W' , sustained in suitable bearings in the frame A, and connected with the forward end of a rearwardly extending bar w , pivoted at w' to the said carriage. The said bar W is located in position for engagement with the pin or stop B^5 , located upon the lower surface of the carriage B and arranged to engage said bar and thereby actuate the shifter W at the same time that the shifter U is moved by the contact of the pin B^4 with the bar U^5 . By this construction the belt P^7 , which operates to move the carriage forward, will obviously be shifted from the fast pulley P^3 to the loose pulley P^4 at the same time that the belt P^8 , driving the carriage backward, is shifted from the loose pulley P^6 to the pulley P^5 .

For the purpose of stopping the movement of the carriage when it reaches the rear end of the machine the sliding bar W' is connected with the rear end of a bar W^2 , pivoted at its forward end to the bed A , and a pin B^6 is arranged upon the forward end of the carriage in position to engage the said bar W^2 , so as to move the belt-shifter W and shift the belt P^8 to the loose pulley P^6 at the desired moment in the rearward movement of the carriage.

In order to save time in the operation of the machine, the rearward movement of the mandrel upon the bed is preferably made simultaneous with the rearward movement of the bed itself, and in order that the mandrel shall reach the rearward limit of its movement at the same time that the carriage reaches the rear end of the frame it is necessary to move the mandrel upon the bed faster than the carriage is moved. For this purpose the belt O^9 , passing over the pulleys O^6 O^7 , by which the mandrel is driven backward, is trained over a driving-pulley O^{11} upon a suitable counter-shaft, said pulley O^{11} being considerably larger than the pulley O^{10} , from which the pulleys O^4 O^5 are driven, thereby giving the desired difference in speed between the forward and rearward movement of the mandrel.

A suitable belt-shifter X is provided for moving the belt O^9 , and means are provided for actuating said shifter, which, as herein shown, are constructed as follows: At the side of the carriage B adjacent to the shaft O^3 is located a longitudinal bar X' , to the end of which the shifter X is rigidly attached. The said bar X' is sustained at its rear end by means of an arm or bracket X^2 , provided with a pin x , passing through an inclined slot x' in the bar X' , and said bar is sustained at its forward end by means of a bracket X^3 , provided with a slot x^2 , inclined in the same direction as the slot x' and engaged by a pin x^3 in the bar X' , the slots x' x^2 and pins x x^3 being so arranged that when the bar is moved bodily downward the said bar will, by the action of the pins in the slots, be given an end movement sufficient to shift the belt from one to the other of the belt-pulleys O^6 O^7 . The said bar X' is held at the forward and upward limit of its movement by means of a spiral spring X^4 , attached to the stud x^4 upon the bar and to the bracket X^2 . The said bar X' is provided with a lateral inwardly-extending rib or flange X^5 , terminating at its forward end in a vertically-swinging hinged latch or pawl X^6 , which is sustained normally in an inclined position, as indicated in Fig. 37, by resting upon the forwardly-projecting part or end X^7 of the said bar X' . Upon the side of the carriage B is located a pin B^7 , adapted to engage the outer upper surface of the inclined pawl X^6 in the rearward movement of the carriage, and to thereby thrust the bar X' downwardly and forwardly to cause the shifting of the belt. The bar when thrust forward is held in this

position by the contact of the said pin B^7 with the flange X^5 until the mandrel has reached the rearward limit of its movement, when the pin passing from the rear end of the said flange allows the bar X' to be thrown backwardly and upwardly by the spring X^4 , thereby shifting the belt O^9 from the fast to the loose pulley and stopping the movement of the mandrel.

The belt-shifting devices for the belt O^9 are preferably so arranged that the backward movement of the mandrel relatively to the carriage will not begin until the carriage is moved backwardly from its extreme forward position a distance about equal to the length of the mandrel, so that the finished tube may be removed from the mandrel before the latter begins to move backwardly from between the clamp-bars E E' E^2 .

In order to prevent possibility of the carriage B being lifted out of place by the action of the lower clamp-bars E upon the mandrel, which clamp-bars are arranged to operate before the other clamp-bars E' E^2 , as before set forth, the frame is provided with rigid hooks A^3 , engaging lateral flanges B^3 upon the said carriage B , as clearly shown in Figs. 1 and 3.

In the particular construction illustrated in the drawings the mandrel is corrugated longitudinally, and the faces of the clamp-bars are shaped to correspond with the surface of the mandrel, so as to give a corrugated form to the tube. As far, however, as the operation of the seaming devices described and shown are concerned, the mandrel may be cylindric, square, or other form, the faces of the clamp-bars in such case being, of course, conformed to the parts of the surface of the mandrel with which they come in contact—as, for instance, in case the mandrel is circular, as shown in the detail sectional view, Fig. 39, the faces of the several clamp-bars will be concaved to fit the curvature of the mandrel. The more important object of making the clamp-bars operate successively, beginning with the clamp-bar beneath the mandrel, is to enable the metal to be forced into the grooves of a corrugated mandrel without stretching it, and when the mandrel is of cylindric form, therefore, a series of clamp-bars operating as above described may be arranged to close upon the mandrel simultaneously or otherwise, as desired. In this connection it may be observed that the number of clamp-bars or clamps may be greater or less than the number shown in the particular machine illustrated with the same general results as far as the operation of the seaming devices is concerned.

It is to be understood that the main or general features of my invention may be carried out by the use of details of construction other than the particular ones which are herein shown and some of them claimed, and said main or general features are therefore herein claimed without restriction to their use in combination with the other parts shown. It

is to be understood, also, that the appended claims cover the devices, parts, or elements therein shown when said devices, parts, or elements are made in form to obtain or perform either any or all of the advantages or functions obtained or performed by them in the particular form thereof herein illustrated.

I claim as my invention—

1. A machine for making pipe, comprising a longitudinally-movable mandrel, clamps holding the sheet metal upon the mandrel, and stationary seam-folders, substantially as described.

2. The combination, with a longitudinally-movable mandrel and clamps for holding the metal upon the mandrel, of rollers acting to bring together over the mandrel the edges of the metal, and stationary seam-folders, substantially as described.

3. The combination, with a longitudinally-movable mandrel and clamps holding the metal upon the mandrel, of rollers acting to close the edges of the metal over the mandrel, a wedge-shaped guide engaging the inner faces of the metal, and stationary seam-folders, substantially as described.

4. The combination, with a longitudinally-movable mandrel and clamps holding the metal upon the mandrel, of stationary seam-folders caused to act by the forward movement of the mandrel and metal to form the seam and a compressing-roller acting upon the folded metal of the seam, substantially as described.

5. The combination, with a longitudinally-movable mandrel and clamps holding the metal upon the mandrel, of rollers for closing the edges of the metal together over the mandrel, a stationary wedge-shaped guide for the edges of the metal, stationary seam-folders, and a compressing-roller acting upon the folded metal of the seam, substantially as described.

6. The combination, with a longitudinally-movable mandrel and clamps holding the metal upon the mandrel, of rollers, as I^1 , for closing the edges of the metal over the mandrel, a stationary wedge-shaped guide located between the said rollers, rollers, as I^3 , for bringing together the edges of the metal, and stationary seam-folders, substantially as described.

7. The combination, with the folder J, operating to bend one edge of the metal over the other edge, of a second folder K, operating to bend the parts folded by the first folder down upon the adjacent part of the metal, substantially as described.

8. The combination, with a longitudinally-movable mandrel and clamps for holding the metal upon the mandrel, of a folder J, operating to bend one edge of the metal over the other edge, and a second folder K, operating to bend the parts folded by the folder J down upon the adjacent parts of the metal, substantially as described.

9. The combination, with the seam-folder

J, having a slot j^2 , and provided with a curved surface j^3 and with an inclined face j^4 , terminating in a groove j^5 , of a second folder K, having a curved slot k^2 , operating to fold the connected parts of the seam down into contact with the adjacent part of the metal, substantially as described.

10. The combination, with a longitudinally-movable mandrel, of seaming devices comprising a seam-folder J, consisting of two parts J^1 and J^2 , each having adjustable connection with the machine-frame, substantially as described.

11. The combination, with the part J^2 of a seam-folder, of a part J^1 , provided with a laterally-adjustable plate J^3 , substantially as described.

12. The combination, with the machine-frame and a mandrel movable longitudinally thereon, of folders, as J or K, made in two separate parts, and supporting-arms, as J^4 or K^3 , for the folders, adjustably attached to the frame, substantially as described.

13. The combination, with a longitudinally-movable mandrel, of stationary seam-folders J and K and a grooved compressing-roller L, mounted in upwardly-yielding bearings, substantially as described.

14. The combination, with a longitudinally-movable mandrel and stationary seaming devices, of a detent engaging the rear end of the finished tube at the forward limit of the movement thereof, whereby the tube will be held from rearward movement with the mandrel, substantially as described.

15. The combination, with a mandrel, of clamps for holding the metal in contact with the mandrel, comprising clamp-bars movable obliquely toward and from the mandrel and gibs located in position for engagement with the ends of the clamp-bars when the latter are remote from the mandrel and in position for engagement with the outer faces of the clamp-bars when the latter are adjacent to the mandrel, the mandrel and clamp-bars having a bodily longitudinal movement relatively to the gibs, whereby the said clamp-bars will be thrown and held by the said gibs in position for clamping the metal, substantially as described.

16. The combination, with a longitudinally-movable mandrel and seaming devices comprising stationary seam-folders, of clamps for holding the metal in contact with the mandrel, comprising two or more clamp-bars movable with the mandrel and also movable obliquely toward and from the latter and stationary gibs located in position for engagement with the said clamp-bars, substantially as described.

17. The combination, with the machine-frame, of a longitudinally-movable mandrel, a carriage sustaining the mandrel, two or more clamp-bars mounted in the carriage and movable therein obliquely toward and from the mandrel, and two or more gibs located upon the machine-frame in position to engage the

clamp-bars in the forward movement of the carriage, substantially as described.

18. The combination, with the machine-frame, of a longitudinally-movable mandrel, a carriage sustaining the mandrel, two or more clamp-bars mounted in the carriage and movable therein obliquely toward and from the mandrel, and two or more gibs sustained upon the frame in position to engage the clamp-bars, said gibs having rearwardly and outwardly yielding connection with the frame to allow the passage by them of the clamp-bars in the backward movement of the carriage, substantially as described.

19. The combination, with the machine-frame, of a longitudinally-movable mandrel, a carriage sustaining the mandrel, two or more clamp-bars mounted in the carriage and movable obliquely toward and from the mandrel, springs applied to hold the said clamp-bars normally free from the mandrel, and gibs located upon the machine-frame in position to engage said clamp-bars, substantially as described.

20. The combination, with the machine-frame, of a carriage B, a mandrel C, mounted upon said carriage, two or more clamp-bars provided with a series of inclined slots, projections or studs upon the carriage engaging said slots, springs applied to retain the clamp-bars at the outer limit of their movement, and gibs supported upon the frame and engaging the said clamp-bars, substantially as described.

21. The combination, with the machine-frame, of a carriage B, a mandrel mounted upon the carriage, two or more clamp-bars provided with a series of inclined slots, studs upon the carriage engaging said slots, and gibs upon the machine-frame engaging the clamp-bars, said clamp-bars being each composed of two adjustably-connected parts, whereby the position of the working-faces of the bars relatively to the mandrel may be varied, substantially as described.

22. The combination, with the machine-frame, of a carriage B, a mandrel sustained upon said carriage, two or more clamp-bars mounted upon the carriage, each consisting of a part e' , provided with inclined slots e , and a part e^2 , adjusting-bolts uniting said parts e' and e^2 , studs upon the carriage engaging said slots, and gibs upon the machine-frame engaging said clamp-bars, substantially as described.

23. The combination, with the machine-frame, of a carriage B, a mandrel sustained upon said carriage, two or more clamp-bars mounted upon the carriage, each consisting of a part e' , provided with inclined slots e , and a part e^2 , adjusting-bolts e^3 , uniting said parts e' and e^2 , studs upon the carriage engaging said slots, and gibs upon the frame engaging the said clamp-bars, the said parts e' e^2 of the clamp-bars being provided with interlocking recesses and projections, substantially as described.

24. The combination, with the machine-frame, of a carriage B, a mandrel sustained upon the carriage, two or more clamp-bars upon the carriage movable obliquely toward and from the mandrel, gibs located upon the machine-frame parallel with the clamp-bars, pivoted links movably connecting said gibs with the frame, stops upon the frame limiting the forward movement of the gibs, and springs applied to normally hold said gibs in contact with the stops, substantially as described.

25. The combination, with the machine-frame, the longitudinally-movable mandrel and clamp-bars, and carriage sustaining said mandrel and clamp-bars, of gibs located upon the frame parallel with the clamp-bars, bars F^3 , sustained upon the machine-frame behind and parallel with the gibs, pivoted links movably connecting said gibs with the bars F^3 , stops upon the frame applied to limit the forward movement of the gibs, springs applied to hold the gibs normally in contact with the stops, and adjusting-screws inserted through the frame and engaging the bars F^3 , substantially as described.

26. The combination, with a longitudinally-movable mandrel, of a series of radially-movable clamp-bars and means acting to advance said clamp-bars successively into engagement with the mandrel, substantially as described.

27. The combination, with the mandrel C and carriage B, of the clamp-bars mounted upon the carriage and movable toward and from the mandrel, and a single clamp-bar D, movable bodily with the mandrel for clamping the metal upon the mandrel before the latter is advanced toward the clamp-bars, substantially as described.

28. The combination, with the machine-frame, of a carriage B, a mandrel C, movable longitudinally upon the carriage, clamp-bars upon the carriage, a sliding support O for the mandrel, mounted in the carriage, and a clamp-bar D, sustained upon and movable with said sliding support, whereby a metal sheet or blank may be clamped to the mandrel, substantially as described.

29. The combination, with the carriage B, of the support O, movable longitudinally upon the carriage, the mandrel C, sustained upon the said support O and movable longitudinally thereon, and a clamp-bar D, connected with the mandrel, the said clamp-bar and support being provided with inclined faces d o , whereby the clamp will be thrown into contact with the mandrel by the relative movement of said support and mandrel, substantially as described.

30. The combination, with the carriage B, of the support O, mounted to slide longitudinally in the carriage, the mandrel C, sustained upon the said support and movable longitudinally upon the latter, a clamp-bar D, connected with the mandrel, said clamp-bar and support being provided with interfitting inclined faces, a detent upon the ma-

chine-frame engaging the mandrel to hold the latter from movement with the support O, and an arm upon the support O, having an inclined face engaging the detent for releasing it from the mandrel, substantially as described.

31. The combination, with the carriage B, of the support O, mounted to slide longitudinally in the carriage, the mandrel C, movable longitudinally upon the support O, a clamp-bar D, located below the mandrel and having vertically-movable connection with the latter, said clamp-bar and the support O having interfitting inclined faces, whereby the clamp-bar is lifted by a forward movement of the support relatively to the mandrel, and a stop upon the forward end of the machine engaging the support O for moving the latter backward to release the clamp bar D from the mandrel, substantially as described.

32. The combination, with the machine-frame, of the carriage B, provided with arms or castings B' B', clamp-bars supported in said castings, a longitudinally-movable support O, provided with a rack-bar upon its lower surface, a mandrel C, sustained upon the said support, a longitudinal shaft O⁸, having bearings upon the machine-frame and upon the said carriage, a transverse shaft mounted in the carriage and provided with a pinion engaging the said rack-bar, and with a beveled gear-wheel o⁵ and a beveled gear-wheel o⁶, mounted to slide but not to rotate upon the shaft, substantially as described.

33. The combination, with the machine-frame and the mandrel C, of a clamp-bar D, acting against the mandrel, and one or more rollers, as n n, mounted upon the machine-frame in position to bear upon the mandrel in opposition to the action of the said clamp-bar, substantially as described.

34. The combination, with the machine-frame, the mandrel C, and clamp-bars, of a longitudinally-movable support for said mandrel, connected with the latter at one end, a clamp-bar D, acting upwardly against the mandrel, a girder N, located longitudinally over the mandrel, and rollers n, mounted upon the girder and constructed to bear upon the top of the mandrel, substantially as described.

35. The combination, with the carriage B and mandrel C, of the support O, constructed to slide longitudinally in the said carriage and provided with a standard having a T-head engaging a correspondingly-shaped slot in the mandrel, a vertical bar D', secured in the mandrel and resting at its lower end upon the support O, and a clamp-bar D, resting upon the support O and united at its one end with the bar D' by a connection permitting vertical movement of the clamp-bar, said support and clamp-bar being provided with interfitting inclined faces, substantially as described.

36. The combination, with the carriage B, mandrel C, and support O, having sliding connection with the mandrel, of the vertical bar

D', secured in the mandrel and resting at its lower end upon the support O, a clamp-bar D, located beneath the mandrel, and a link d', pivoted at its ends to the clamp-bar D and the bar D', said clamp-bar D and support O having interfitting inclined faces, substantially as and for the purpose set forth.

37. The combination, with the machine-frame and carriage B, of the mandrel C, mounted upon the carriage and movable longitudinally of the latter, a clamp-bar H, supported upon the carriage, a rod H', mounted in the carriage and provided with eccentrics engaging the said clamp-bar H, and with a pin h² and a casting H² upon the frame, provided with a cam-slot engaging the said pin h², whereby the rod is rotated by the forward movement of the carriage, substantially as described.

38. The combination, with the machine-frame and the carriage B, of the mandrel C, mounted upon the carriage, a clamp-bar H, supported upon said carriage, a shaft H', having bearings in the carriage and provided with eccentrics engaging the said clamp-bars, and with a pin h² at its rear end and an arm H⁵ at its forward end, a casting H² upon the frame, provided with a cam-groove engaging the rod for rotating the latter in tightening the clamp-bar, and a stationary cam-plate H⁶, constructed to engage the arm H⁵ at the forward limit of the movement of the carriage, substantially as described.

39. The combination, with the machine-frame and the carriage B, of the mandrel C, mounted upon the said carriage, two radially-movable clamp-bars H H, shafts H' H', mounted in the carriage and provided with eccentrics engaging the bars, and intermeshing gear-wheels upon said shafts, one of said shafts being provided with a pin h² at its rear end and an arm H⁵ at its forward end, a casting upon the machine-frame provided with a cam-groove engaging the said pin h², and a stationary cam-plate H⁶, engaging the arm H⁵ at the forward limit of the movement of the carriage, substantially as described.

40. A machine for making corrugated metal pipe, comprising a longitudinally-movable mandrel, a series of radially-movable clamp-bars operating to press the metal blank into contact with the surface of the mandrel, and stationary seam-folders acting upon the blank in the forward movement of the mandrel, substantially as described.

41. The combination, with a longitudinally-movable mandrel, of laterally-movable folders for bending the blank about the mandrel and clamp-bars for forcing the metal blank into contact with the mandrel, substantially as described.

42. The combination, with a longitudinally-movable mandrel and clamps for holding the sheet-metal blank upon the mandrel, of a clamp-bar movable with the mandrel for holding a flat blank in position upon said mandrel and laterally-movable folders for

bending the lateral margins of the blank about the mandrel, substantially as described.

43. The combination, with the machine-frame, a carriage B, and a mandrel C, mounted to slide longitudinally upon the carriage, of clamp-bars upon the carriage for forcing the metal blank into contact with the mandrel, laterally-movable folders upon the carriage for bending the blank about the mandrel, and stationary cam-surfaces upon the machine-frame actuating said folders in the forward movement of the carriage, substantially as described.

44. The combination, with the machine-frame, a carriage B, and a mandrel C, mounted to slide longitudinally upon the carriage, of laterally-movable folders upon the carriage for bending the blank about the mandrel, stationary cam-surfaces upon the machine-frame actuating said folders in the forward movement of the carriage, clamp-bars upon the carriage movable obliquely toward and from the mandrel, and gibs upon the machine-frame engaging said clamp-bars in the forward movement of the carriage, substantially as described.

45. The combination, with the machine-frame, the carriage B, movable thereon, and the mandrel C, mounted to slide longitudinally upon the carriage, of folders upon the carriage, comprising plates G' , mounted to slide obliquely upon the carriage, and flaps G^2 , hinged to the parts G' , rollers upon the frame engaging said plates G^2 , and cam-surfaces upon the frame engaging and moving the flaps G^2 , substantially as described.

46. The combination, with the machine-frame, the carriage B, and mandrel C, of folders comprising laterally-movable plates G' , provided with inclined faces at their forward ends, and flaps G^2 , hinged to the plates G' , the said carriage being provided with oblique guides for the said parts G' , rollers mounted upon the frame and engaging the inclined faces of the said plates G' , and stationary cam-surfaces upon the frame engaging and actuating the flaps G^2 , substantially as described.

47. The combination, with the machine-frame, the carriage B, and mandrel C, of laterally-movable folders, stationary cam-surfaces engaging and actuating the said folders in the forward movement of the carriage, and longitudinal guides upon the frame engaging the said folders after they have been closed upon the mandrel, substantially as described.

48. The combination, with the machine-frame, the carriage B, and mandrel C, of folders comprising obliquely-movable plates G' and flaps G^2 , hinged to the plates, rollers upon the machine-frame engaging said plates G' , stationary cam-surfaces upon the frame engaging and actuating the said flaps, and stationary longitudinal guides upon the frame

adapted to engage the free edges of said flaps, substantially as described.

49. The combination, with the machine-frame, the carriage B, and mandrel C, of folders comprising obliquely-movable plates G' and flaps G^2 , hinged to the said plates and provided with projections g^4 upon their free edges, rollers upon the machine-frame engaging said plates G' , stationary cam-surfaces upon the frame engaging said flaps, and stationary longitudinal guides G^6 upon the frame, provided with guide-slots g^3 , adapted for engagement with said projections g^4 , substantially as described.

50. The combination, with the machine-frame and carriage B, of a mandrel C, sustained upon the carriage, radially-movable clamp-bars provided with inclined slots e , arms or castings $B' B'$ upon the carriage, consisting of a series of parts B^3 , provided with connecting-posts b^4 and forming bearings for said clamp-bars, studs secured in the said castings and engaged with the slots e , and gibs supported upon the machine-frame in position for engagement with the said clamp-bars, substantially as described.

51. The combination, with the machine-frame, the carriage B, mandrel C, and radially-movable clamp-bars $E E' E^2$, of arms or castings $B' B'$, forming bearings for the said clamp-bars, the lower bearing-surfaces for the said bars being provided with transverse ribs sustaining the bars and forming spaces below the bars, substantially as and for the purpose set forth.

52. The combination, with the machine-frame, the mandrel C, laterally-movable clamp-bars, and the carriage B, provided with arms or castings $B' B'$, sustaining the said clamp-bars, of arms Q upon the frame engaging the outer surfaces of the arms $B' B'$ to relieve the outward strain upon the latter, substantially as described.

53. The combination, with the machine-frame, the mandrel C, the laterally-movable clamp-bars, as E, provided with inclined slots e , and the carriage B, provided with arms or castings $B' B'$, sustaining the clamp-bars and provided with studs engaging the slots e , of gibs upon the frame engaging the said clamp-bars and arms or castings Q upon the frame engaging the outer surface of said arms $B' B'$, substantially as described.

54. The combination, with the machine-frame, the carriage B, mandrel C, and sliding support O, of the shaft O^3 , actuating the said sliding support, provided with fast and loose pulleys, a belt-shifter V, a lever V' , connected with said belt-shifter for actuating the latter, a rod V^2 , connected with the said lever and provided with a projection v^4 at its forward end, a projection or pin C^3 , located upon the mandrel in position to engage said projection v^4 , a second projection or pin C^4 upon the mandrel, a driving-shaft P' for the carriage, provided

with fast and loose pulleys, a belt-shifter U, and a movable bar U³, having an inclined surface adapted for engagement with the pin C⁴ and connected with the belt-shifter U for moving the latter, substantially as described.

55. The combination, with the carriage B, the mandrel C, provided with a projection or pin C⁴, the laterally-movable folders G upon the carriage, and a shaft P', actuating the carriage, provided with fast and loose pulleys, of a belt-shifter U, a bar U³, connected with the belt-shifter and provided with an inclined surface located in the path of the pin C⁴, and with a laterally-projecting part or wing w⁵, adapted for engagement with one of the folders G, substantially as described.

56. The combination, with the carriage B, the mandrel C, provided with a projection or pin C⁴, the laterally-movable folders G upon the carriage, and a shaft P', provided with fast and loose pulleys, of a belt-shifter U, a bar U³, connected with the belt-shifter and provided with an inclined surface located in the path of the pin C⁴ and with a projecting part or wing w⁵, located in position for engage-

ment with the folders G, and a second bar U⁴, also connected with the belt-shifter and provided with an inclined surface engaging the pin C⁴ at the forward limit of the movement of the mandrel upon the carriage, substantially as described.

57. The combination, with the carriage B, the mandrel C, and the sliding support for the mandrel, of the driving-shaft O³, for moving said support, provided with two sets of fast and loose pulleys, belt-shifters U and X for said pulleys, and means for actuating the shifter X, consisting of an obliquely-movable bar X', provided with a flange X⁵ and with a hinged latch X⁶, a spring applied to hold the bar at one limit of its movement, and a stud B⁷ upon the carriage engaging said flange, substantially as described.

In testimony that I claim the foregoing as my invention I affix my signature in presence of two witnesses.

ORLANDO P. BRIGGS.

Witnesses:

G. CLARENCE POOLE,
M. E. DAYTON.