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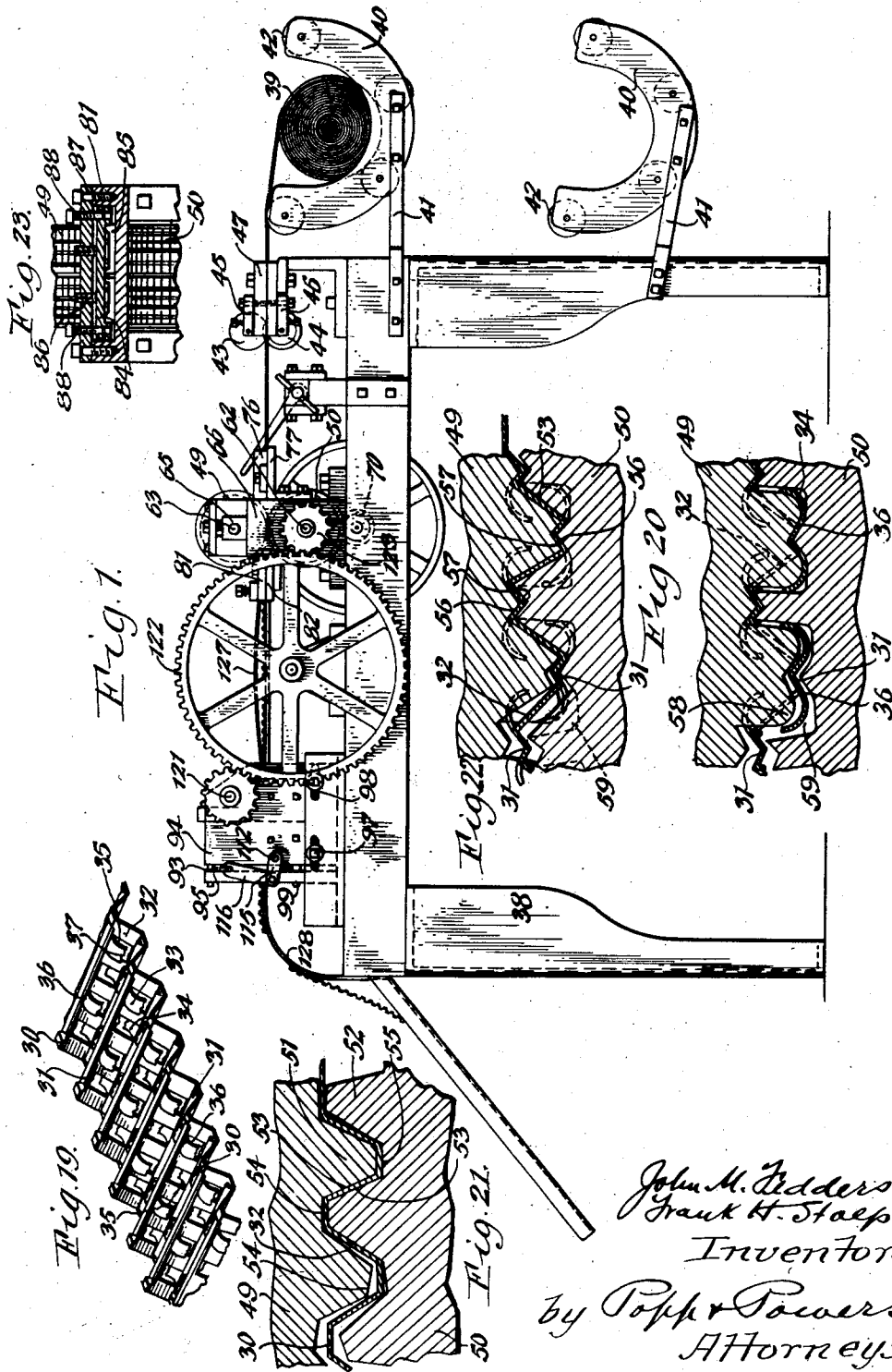
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MACHINE FOR PREPARING METAL STRIPS

Filed May 5, 1925

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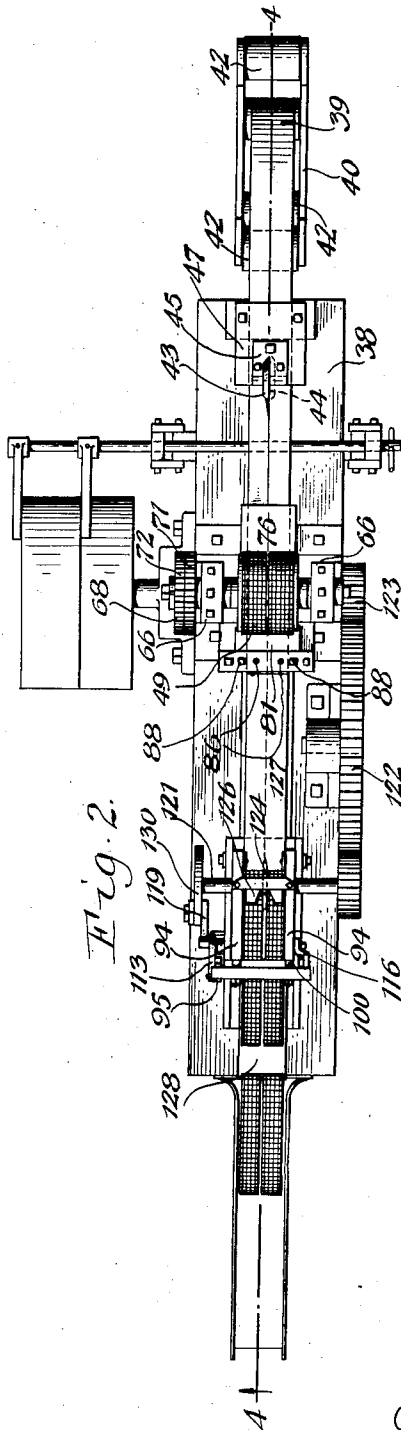
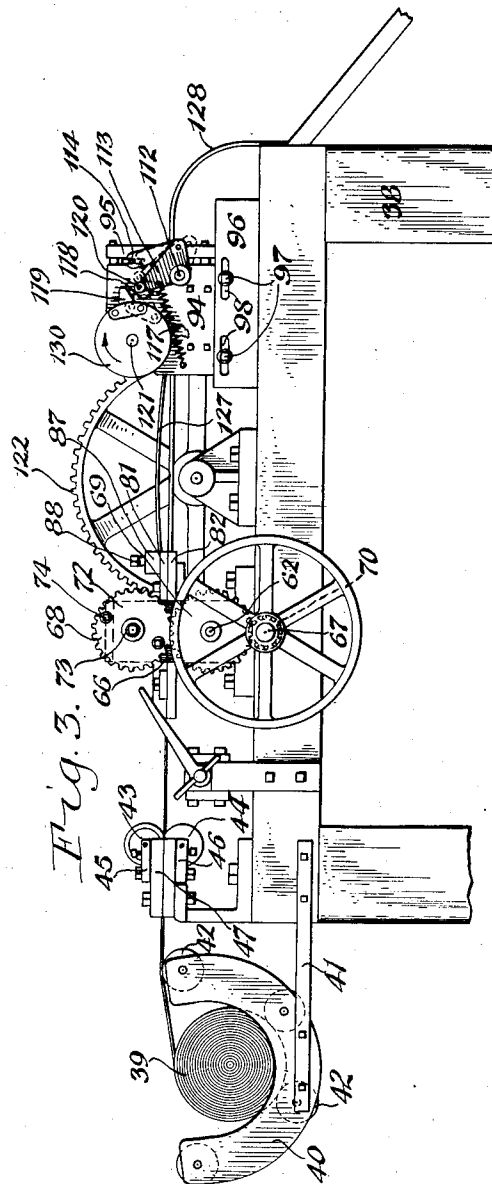
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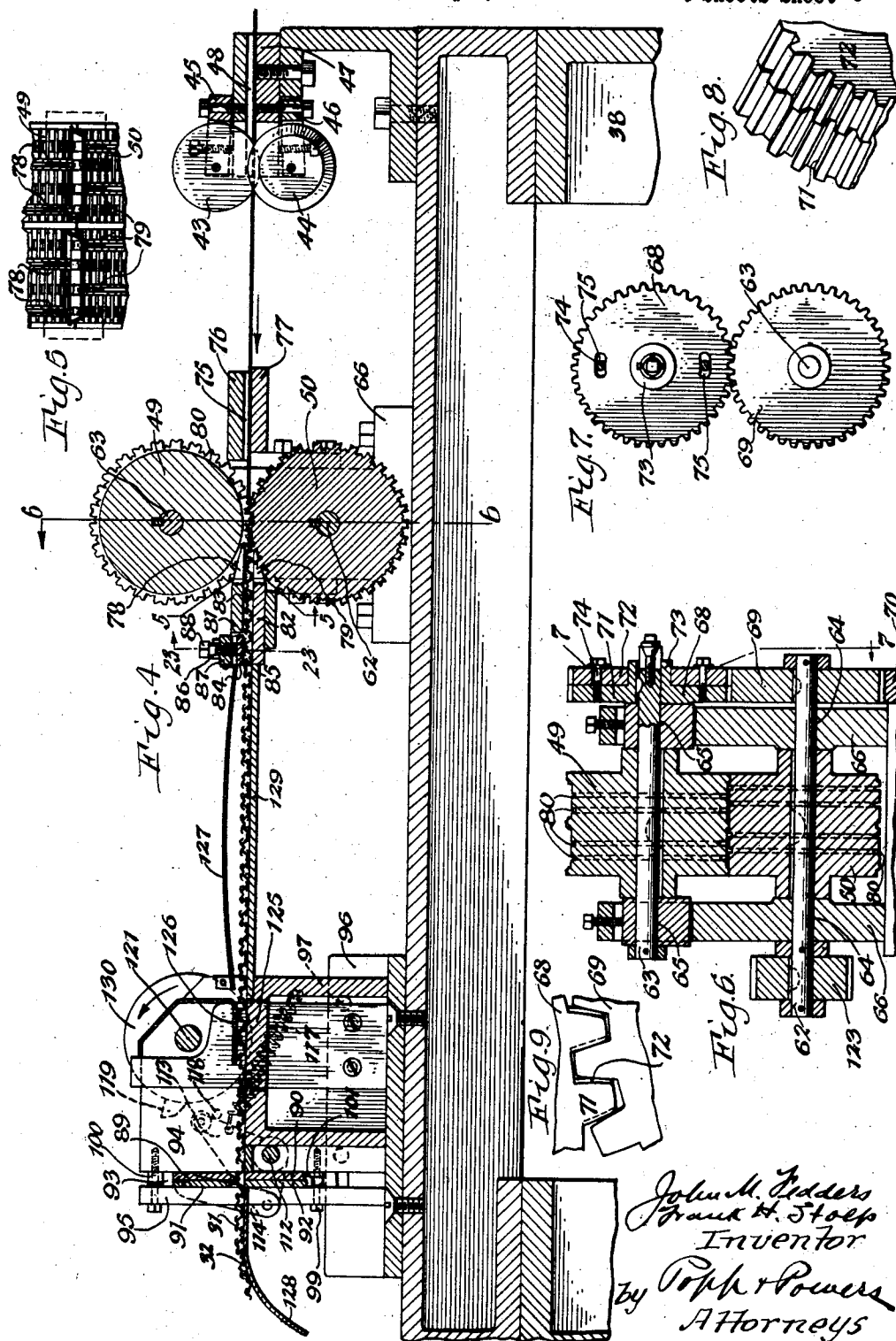
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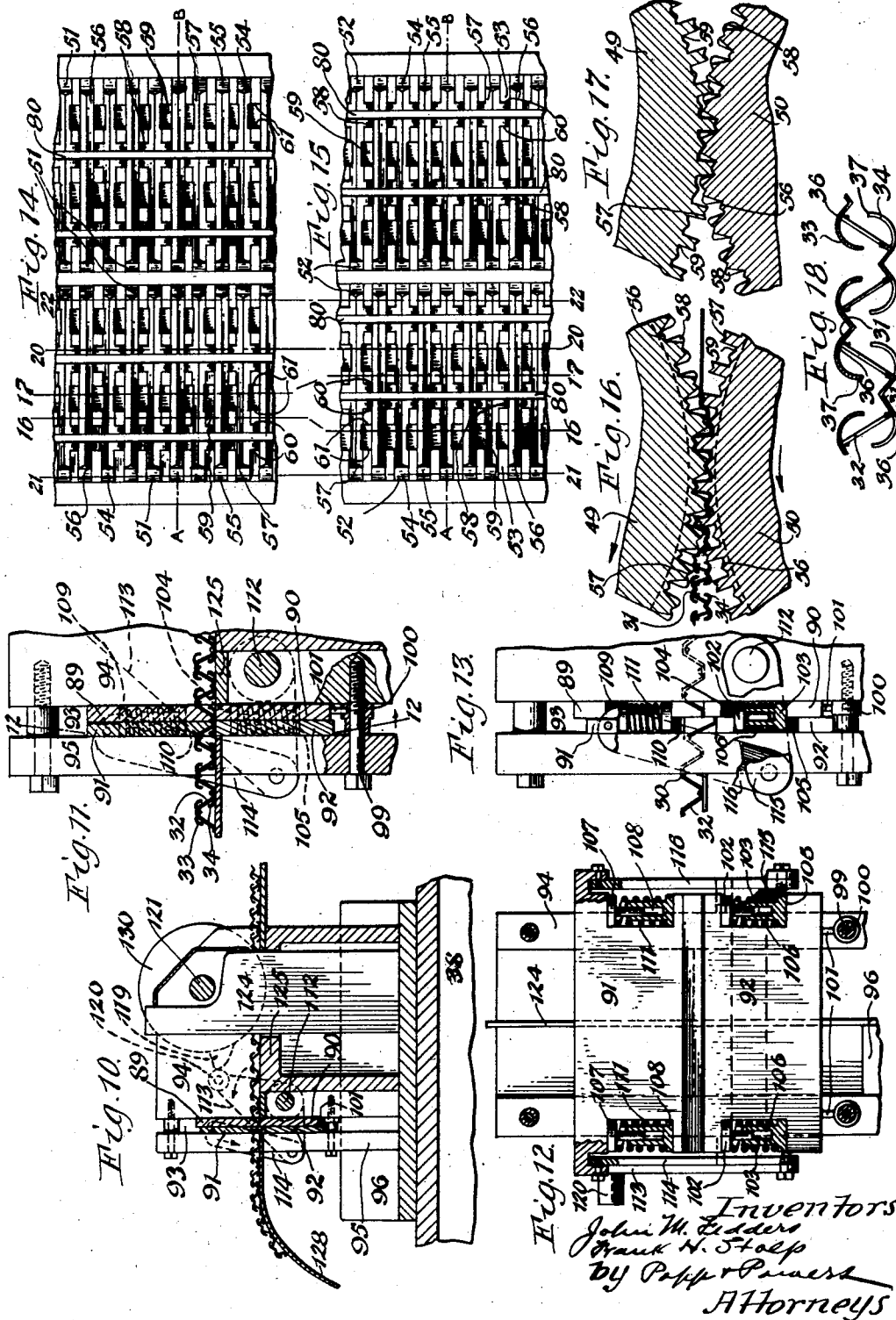
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MACHINE FOR PREPARING METAL STRIPS

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UNITED STATES PATENT OFFICE.

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MACHINE FOR PREPARING METAL STRIPS.

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This invention relates to a forming machine for making strips of metal having certain peculiarities of structure to render the same suitable for use as radiating fins in connection with the corrugated walls of water tubes in radiators commonly employed for cooling the water of gas engines.

It is the purpose of this invention to provide an improved forming machine of this character having greater capacity and adapted to operate on a strip of metal so as to provide the same with corrugations corresponding to and interlocking with similar corrugations on the water tube walls, and also with radiating wings, lugs or ears which are of peculiar form and struck out of the metal constituting the inclined webs of the strip and thereby increase the radiating efficiency for a given amount of metal.

In the accompanying drawings:

Figure 1 is a side elevation of a forming machine embodying our improvements.

Figure 2 is a top plan view of the same.

Figure 3 is a fragmentary side elevation of the machine viewed from the side opposite to Figure 1.

Figure 4 is a fragmentary vertical longitudinal section, on an enlarged scale, of the machine.

Figure 5 is a fragmentary vertical transverse section, on an enlarged scale, taken on line 5—5, Fig. 4.

Figure 6 is a vertical cross section taken on line 6—6, Fig. 4.

Figure 7 is a vertical section taken on line 7—7, Fig. 6.

Figure 8 is a fragmentary perspective view of the adjustable take-up gear wheel.

Figure 9 is a fragmentary side elevation of the take-up gear wheel and the companion gear wheel meshing therewith.

Figure 10 is a fragmentary vertical longitudinal section of the cutter mechanism showing the position of the parts in the cutting position.

Figure 11 is a similar view on an enlarged scale showing the corrugated strip gripped by the cutter mechanism preparatory to cutting the same.

Figure 12 is a vertical cross section taken on line 12—12, Fig. 11.

Figure 13 is a fragmentary side elevation,

partly in section of the cutter mechanism showing the parts in the cutting position corresponding to Figure 10.

Figures 14 and 15 are fragmentary face views, full size, of the die wheels whereby the strips of metal are corrugated and provided with radiating wings, lugs or ears.

Figures 16 and 17 are vertical sections taken on the correspondingly numbered lines in Figures 14 and 15.

Figure 18 is a fragmentary longitudinal section of the radiator fin produced by our improved forming machine.

Figure 19 is a perspective view of a finished portion of this strip.

Figures 20, 21 and 22 are fragmentary vertical sections taken on the correspondingly numbered lines in Figure 6 and showing the manner in which the faces of the die wheels operate on the sheet metal to produce the form shown in Figures 18 and 19.

Figure 23 is a vertical cross section taken on line 21—21, Figure 4.

Similar characters of reference indicate like parts throughout the several views.

The formed radiating fin produced by our improved machine consists of a strip of metal which is corrugated or bent into zig-zag form the transverse summits of the corrugations on one side of the strip alternating with and arranged midway between the summits on the other side of the strip, and the slopes or webs of the corrugations being inclined and extending from the summits on one side of the strip to the summits on the other side of the same. Each of the summits has its extremities provided with flat bearing faces 30 adapted to engage with corresponding bearing faces on the corrugated walls of an adjacent water tube and the intermediate part of each summit is reversely bent to form an inwardly projecting channel or concave seat 31 which is adapted to receive a corresponding convex seat on an adjacent corrugated water tube wall and thereby become centered relative thereto and interlocked against displacement. Each of the sloping sides or webs 32 of the radiating fin is provided with a plurality of radiating wings, lugs or ears 33, 34 which are of curved form and have their convex sides

facing outwardly. The radiating wings of each web project laterally therefrom on opposite sides thereof and the wings on one side of each web alternate with the wings on the other side of the same. Furthermore each wing of each web on one side thereof has its base connected integrally therewith adjacent to one of the summits of this web and each wing on the opposite side of this web has its base connected integrally with the web adjacent to the other summit of this web. Each of these wings is formed by cutting the metal of the web at opposite longitudinal edges 35 of the wing, but the base 36 of the wing remains permanently connected with the respective web and the free or outer end of each wing has its transverse edge torn from the stock of the metal forming this web, thereby producing a ragged edge 37 on the free end of the wing, which increases the radiating capacity of the same.

The machine shown in the drawings and containing the preferred form of our invention is constructed as follows:

The numeral 38 represents the main frame which may be of any suitable construction to support the several parts of the mechanism. On the front end of this frame are mounted the supply means which support rolls 39 of double width sheet metal of which the fins are made; in rear of the feeding means is the longitudinal slitter or cutter mechanism whereby the sheet metal is cut into two parallel strips; in rear of the slitter is arranged the forming mechanism whereby the strips are bent to provide the same with corrugations having the bearing faces, interlocking grooves and radiating wings; and in rear of the forming means is arranged the transverse cutting or severing mechanism whereby the finished strip is cut into sections of the requisite length.

The supply means preferably consist of an upper support or rack mounted on the upper part of the front end of the main frame and adapted to carry the roll of sheet metal which is being fed to the machine and a lower support or rack mounted on the main frame below the upper support and adapted to carry a roll of sheet metal which is held in reserve ready to be used when the roll in the upper support becomes exhausted. Each of these supports is constructed generally in the form of a cradle and comprises two downwardly curved side pieces 40 which are spaced apart and connected by bars 41 with the adjacent part of the main frame, and a plurality of transverse rollers 42 arranged between the side bars in a downwardly curved row and pivotally mounted at their ends thereon. By this means a roll of sheet metal supported on these rollers will be able to turn freely and pay out the ribbon of metal from the periphery of the rolls as the same is pulled off by the forming

mechanism which crimps, corrugates and forms the metal into the desired shape.

As the ribbon of sheet metal moves forwardly the same passes between the opposing overlapping parts of upper and lower longitudinal cutter disks 43, 44 which sever the ribbon into two parallel strips preparatory to forming the same suitable for use as a fin for radiators. These cutter disks are mounted on upper and lower cutter heads 45, 46 which are in turn adjustably secured to a guide block 47 mounted on the main frame and provided with a guide opening 48 through which the sheet metal ribbon passes on its way to the longitudinal cutter disks.

After the ribbon has been thus slitted into two longitudinal parallel strips the latter continue their forward movement side by side and pass between the opposing complementary die surfaces of upper and lower die rollers or wheels 49, 50 which turn about horizontal parallel axes arranged transversely of the direction of travel of the sheet metal strips. The die surfaces of these die rollers are constructed to simultaneously form two strips into the desired shape for use as fins in a radiator, but the following description of one die section of each of the die rollers and the one die section of the cooperating part of the companion roller will therefore apply to the cooperating parts of the two die sections of both of these rollers.

The corrugations in each of the metal strips are produced by die teeth 51, 52 which are arranged transversely on the periphery of the die rollers and intermesh in the manner of gear wheels and each of which has inclined sides 53 cooperating with similar sides on the die teeth of the other die roller and flat outer faces 54 at opposite ends of the tooth which are adapted to co-operate with flat inner faces 55 at opposite ends of the space between two teeth on the other roller, thereby forming corrugations of substantially V-shape in the strip of metal, the summits at opposite ends of which are flat and form the bearing faces 30, as shown in Figure 21. That part of the valley between two adjacent die teeth of each die roller and intermediate of its flat end faces 54, is provided with a die rib 56 which is adapted to operate with a longitudinal die groove 57 on the summit of an opposing die tooth on the other die roller between the flat end faces 55 thereof, thereby forming the reversely bent interlocking channels or grooves 31 in the summits of the corrugations which engage with the summits of corrugations on the water tube walls, as shown in Figure 22. At different points in the length of the inclined sides of each die tooth the same is provided with deflecting punches 58 having rounded outer ends which are adapted to project laterally from the re-

spective die tooth of one die roller into deflecting recesses 59 in the inclined sides of the corrugating teeth on the other die roller. The opposite longitudinal edges 60, 61 of each of these deflecting punches and recesses are sharp and operate upon engaging a web portion of the sheet metal strip to cut two parallel longitudinal slits in the same which form the opposite edges 35 of a radiating wing, lug or ear 33. The deflecting punch 58 is so constructed that the same engages with the metal forming a wing 33 at the outer end of the latter slightly in advance of its inner end with the result that the outer end is torn off from the adjacent web of the corrugated strip, and then pressed outwardly into curved form beyond the web while the inner edge of the wing remains integrally connected with the respective web, as shown in Figure 20. Upon tearing the outer edge of each wing from the respective web of the corrugated strip ragged edges are formed on the web and wing where the same have been separated, thereby causing the air to engage the same more effectively when flowing through the completed radiator of which it forms a part and thus increasing its cooling efficiency. Furthermore, by tearing away one end of each wing instead of cutting the same by a punch the cost of producing the dies and the maintenance of the same is reduced accordingly. Moreover by staggering the points of connection between each web and the wings formed on the same the strip is not weakened as would be the case if the tearing points of the several wings of a web were all arranged in a line.

In the drawings the dies are so constructed that four radiating wings are formed on each web of the corrugated strip, two projecting from each side thereof and alternating with those on the other side, but obviously this number may be varied to suit the size of radiator required.

When the machine is in operation the die rollers while forming the strips passing between the same also act as feed wheels or rollers whereby the strips are positively fed from the supply roll forwardly through the machine. For this purpose the die rollers are mounted and operated so that the same move forwardly on their opposing working sides in unison. The means for this purpose shown in the drawings comprise lower and upper transverse shafts 62, 63, carrying the lower and upper die rollers and journaled in bearings 64, 65, arranged on standards 66 rising from the main frame, a driving shaft 67 journaled horizontally and transversely in bearings on the main frame and receiving power from any suitable source, intermeshing gear wheels 68, 69, mounted on corresponding ends of the die roller shafts, and a driving gear pinion 70 arranged on the main shaft and meshing with the lower

driven gear wheel 69, as shown in Figs. 1, 3 and 6.

For the purpose of taking up slack and wear between the upper and lower gear wheels of the die rollers, means are provided which consist in making this gear in two sections 71, 72 which are arranged side by side on the upper die roller shaft and one of the sectional gear wheels, for example the inner section 71, is secured to the die roller shaft 62 and the other roller is loosely mounted on the hub 73 of the inner section and these two gear wheel sections are adjusted circumferentially relatively to each other by screws 74 secured to the rear or inner wheel section 71, passing with their shanks through circumferential slots 75 in the outer section 72 and bearing with heads against the latter through the medium of washers, as shown in Fig. 6. By this means the two gear wheel sections 71, 72 can be adjusted so that in effect each of its teeth is widened and adapted to fit closely in the spaces between the teeth of the other section, as shown in Fig. 9, thereby permitting of taking up wear and avoiding gear noise when the parts become worn.

The sheet metal strips to be formed are directed to the opposing parts of the die rollers by passing the same through a guide slot or opening 75 formed between two bars or plates 76, 77 mounted on the standards 66.

It has been found in practice that the strips of metal tend to stick to the die rollers after the strips have been formed therebetween. To facilitate such removal a stripping device is provided which preferably comprises upper and lower stripping fingers 78, 79 arranged on the rear side of the die rollers and projecting into circumferential grooves 80 therein close to the intermeshing parts thereof so as to engage with the upper and lower sides of the formed strips on the discharge side of the die rollers and thus forcibly eject the strips from these rollers if the strips tend to cling thereto. These stripping fingers are mounted on upper and lower guide bars or plates 81, 82 supported on the adjacent parts of the standards and forming between them a guide slot or opening 83 which receives the formed strips.

Owing to differences in the character of the sheet metal and also the form of the deflecting punches and recesses the wings are torn off irregularly at their outer ends from the webs of the corrugated strip, thereby causing the wings to project laterally different distances from the strip when the same issues from the rear side of the bight between the die rollers. To permit of evening these wings so that they project laterally a uniform distance from opposite sides of the corrugated strip evening means are provided which preferably consists of a flattening or evening bar 84 arranged over the rear

part of the lower guide plate 82 and forming with the latter a guide slot 85 of reduced width so that when the corrugated strips having the wide spread wings passes through this slot, these wings will be pressed together by reason of this slot being narrower than the wings and thereby cause all of the wings to be spread alike which permits of stacking and assembling the fins more readily with the water tubes and also ensures uniformity in the radiating action of the radiator core into which the same is incorporated.

The width of the reducing slot 85 may be varied to suit different requirements for which purpose an adjusting device is provided which preferably comprises two push screws 86 mounted on the stationary frame bar 87 and bearing against the top of the evening bar 84 and two draw screws 88 connecting the stationary frame bar 87 with the flattening or evening bar 84, as shown in Figures 4 and 23, whereby upon tightening one set of these screws and loosening the other the flattening bar can be adjusted to suit the width of slot 85 as required. After the wings of the formed strip of metal have been pressed back so that they are of uniform width the strip is presented to a transverse cutter mechanism whereby the strip is cut in lengths or sections suitable for use in the radiator core for which it is intended. This cutter mechanism in the preferred form shown in the drawings is constructed as follows:

Referring to Figures 1-4 and 11-13 the numerals 89 and 90 represent a pair of front cutter plates normally arranged above and below the path of the formed strip of sheet metal, and 91, 92 represent a pair of rear cutter plates normally arranged above and below the path of said strip in rear of the front pair of cutter plates. These two pairs of plates are in contact with their opposing inner sides and have their outer sides in engagement with the upright sides of vertical slots 93 which are formed between a pair of front side pieces 94 arranged along opposite edges of the path of the metal strips and engaging with the front sides of the front cutter plates and a pair of rear side pieces 95 arranged along opposite edges of the path of the metal strips and engaging with the rear sides of the rear pair of cutter plates. The front cutter plates are secured at their lower ends to longitudinal flanges 96 on the rear part of the main frame by screws 97 secured to the front side pieces 94 and passing through horizontal slots 98 in the frame flanges 96, and the rear side pieces are held in place by means of screws 99 connecting the same with the front side pieces and spacing sleeves 100 mounted on the screws 99 and interposed between said front and rear side pieces. The front side

pieces are secured to opposite sides of a table 125 over which the strips of metal move and are guided as they approach the transverse cutter.

The front lower plate 90 forms the lower blade of a pair of cutting shears and is adapted to support the metal strips on the under side for which purpose it is held stationary by means of pins 101 on its underside resting on the sleeves or collars 100, as shown in Figures 11-13. The upper front plate 89 operates as a clamp which is vertically movable toward and from the top of the metal strips and adapted to hold the latter down against the lower cutter blade 90. The upper rear plate 91 serves as an upper cutter blade and is vertically movable toward and from the upper side of the metal strips and past the lower front cutter blade 90 so as to operate in conjunction with the latter as a cutting shears, whereby the metal strips are severed at this point. The lower front plate 92 operates as a clamping member which engages with the underside of the metal strips and moves vertically with the upper rear cutter blade 91. The lower and upper cutter plates are yieldingly held in an elevated position by spring means which preferably consist of two pairs of telescopic bearing members 102, 103 arranged in notches 104, 105 in opposite ends of the lower plates 90, 92 and the members of each pair being adapted to engage upper and lower shoulders formed on these plates by said notches, and a pair of springs 106 each resting at its opposite ends on a pair of said bearing members. The upper rear cutter member and upper front clamping member are yieldingly connected by spring means which preferably comprise two pairs of telescopic bearing members 107, 108 arranged in notches 109, 110 in opposite ends of the upper plates 89, 91, and the members of each pair being adapted to engage upper and lower shoulders formed on these plates by said notches, and a pair of springs 111 each resting at its opposite ends on a pair of said bearing members, as best shown in Figures 10, 12 and 13.

Upward movement of the rear cutter plate 91 and associated parts is effected by a horizontal rock shaft 112 journaled transversely in bearings on the front side pieces below the path of the metal strip, a rock arm 113 arranged on one end of the rock shaft and connected by a link 114 with the adjacent end of the upper rear cutter blade, a rock lever 115 arranged on the opposite end of the rock shaft and connected by a link 116 with the opposite end of the upper rear cutter blade, a spring 117 connecting the rock arm 115 with the adjacent front side piece and operating to raise the rear cutter blade and the parts connected therewith and a stop pin 118 which arrests

the upward movement of the upper rear blade 91 under the pull of the spring 117 and which is mounted on the adjacent rear side piece. Downward movement of the upper rear cutter blade and associated parts is effected by a rotary cam 119 adapted to engage a tappet or roller 120 on the rock lever 115 during each rotation, a disk 120 carrying said cam and mounted on a transverse shaft 121 which is journaled in bearings on the upper part of the front side pieces of the transverse cutter mechanism, and a large intermediate gear wheel 122 pivotally mounted on the main frame and meshing on one side with a gear pinion 123 on the shaft of the lower die roller and on its opposite side with a gear pinion on the cam shaft 121, as shown in Figures 1, 2, 3, 10-13.

In the inoperative position of the transverse cutter mechanism the rock lever 115 is held against the stop pin 118 by the spring 117, the upper cutter plates 89, 91 are both elevated, and the lower rear clamping member 92 is elevated and stands with its upper edge flush with the upper end of the front lower clamping member 90 next to the path of the metal strip, as shown in Figure 4, during which time the latter is being fed forwardly between the blades of the cutter mechanism. At a predetermined period and when the metal strip has been advanced the required distance in accordance with the length desired, the cam engages the tappet and turns the rock lever and thereby quickly pulls down the rear cutter blade and then releases it so that it can fly up again without interfering with the forward feed of the metal strip which is continuous. During the downward movement of the rear upper blade the upper front clamping member moves downwardly with it until the latter engages the upper side of the metal strip, as shown in Figure 11. Thereafter the upper rear cutter blade continues its descent and during this time engages with the top of the metal plate and depresses the same together with the lower rear clamping member 92 which at this time supports the underside of the metal plate and holds the same against the underside of the rear cutter blade, thereby carrying that part of the metal strip which is gripped between the rear plates 91, 92 downwardly past that part which is gripped between the front plates 89, 90, and severing the metal strip, as shown in Figures 10 and 13. During the subsequent upward movement of the rear cutter blade 91 the lower rear clamping member 92 is also raised by the spring devices between the same and the front lower cutter blade 90. Thereafter the rear cutter blade completes its upward movement independently of the lower rear clamping member 92 and during this time the front clamping member 89 rises with the rear cutter blade 91 and is lifted

from the metal strip by the yielding connection between the upper front and rear cutter plates.

The faces of the cutter plates are made to conform to the shape of those parts of the metal strip with which they engage so as to obtain a firm hold thereon without distorting the shape of the same.

By loosening the bolt and slot connection between the front side pieces of the transverse cutter it is possible to accurately adjust the position of this cutter relatively to the forming mechanism. By changing the ratio of the gearing between the forming mechanism and the transverse cutter mechanism the latter may be operated at shorter or longer intervals to suit the length of metal strips required.

In order to keep the two metal strips apart while passing the transverse cutter a dividing blade 124 is provided, the same being mounted vertically between the paths of the strips on the front part of the table 125 and the metal strips are held close to the top of the latter so as to be reliably guided toward the transverse cutter by an upper guide plate 126 mounted on the front side pieces and extending over the path of the metal strips, as shown in Figures 2 and 4. As the formed strip of metal moves from the forming mechanism to the transverse cutting mechanism the same is supported on its underside by a guide table 129.

In order to prevent undue upward deflection of the metal strips between the transverse cutter and the forming mechanism as the rollers of the latter push the strips forward a retaining plate 127 is provided which extends lengthwise over the path of the metal strip between the flattening device and the transverse cutter mechanism and is supported on suitable stationary parts of these devices, as shown in Figures 2, 3 and 4.

After a section or length of metal strip has been severed from the main part or body of the same the severed part is directed by a downwardly curved deflector or guide plate 128 to a suitable receptacle or place of deposit provided for that purpose.

We claim as our invention:—

1. A machine for preparing strips of metal comprising two die members, each member having a plurality of V-shaped die teeth adapted to engage between adjacent teeth of the other die member the opposite ends of the summits of the teeth of each member having flat faces and the valley between adjacent teeth also having flat faces and adapted to co-operate with the corresponding flat faces of the other member and the summits of each tooth on one member being provided between the corresponding flat faces with grooves and the valleys between adjacent teeth thereof being provided with a rib between the flat faces therein and

adapted to co-operate with corresponding grooves and ribs on the other die member and the sides of a tooth of each die member being provided with a deflecting punch and with a deflecting recess adapted to co-operate with a deflecting recess and punch of the other die member.

2. A machine for preparing strips of metal comprising two die members, each member having a plurality of V-shaped die teeth adapted to engage between adjacent teeth of the other die member, the opposite ends of the summits of the teeth of each member having flat faces and the valley between adjacent teeth also having flat faces and adapted to co-operate with the corresponding flat faces of the other member and the summits of each tooth on one member being provided between the corresponding flat faces with grooves and the valleys between adjacent teeth thereof being provided with a rib between the flat faces therein and adapted to co-operate with corresponding grooves and ribs on the other die member and the sides of a tooth of each die member being provided with a deflecting punch and with a deflecting recess adapted to co-operate with a deflecting recess and punch of the other die member, the ends of said deflecting punches being rounded.

3. A machine for preparing strips of metal comprising two die members, each member having a plurality of V-shaped die teeth adapted to engage between adjacent teeth of the other die member, the opposite ends of the summits of the teeth of each member having flat faces and the valley between adjacent teeth also having flat faces and adapted to co-operate with the corresponding flat faces of the other member and the summits of each tooth on one member being provided between the corresponding flat faces with grooves and the valleys between adjacent teeth thereof being provided with a rib between the flat faces therein and adapted to co-operate with corresponding grooves and ribs on the other die member and the sides of a tooth of each die member being provided with a deflecting punch and with a deflecting recess adapted to co-operate with a deflecting recess and punch of the other die member, said deflecting punches and recesses being provided only with longitudinal cutting edges.

4. A machine for preparing strips of metal comprising two die members, each member having a plurality of V-shaped die teeth adapted to engage between adjacent teeth of the other die member, the opposite ends of the summits of the teeth of each member having flat faces and the valley between adjacent teeth also having flat faces and adapted to cooperate with the corresponding flat faces of the other member and the summits of each tooth on one member

being provided between the corresponding flat faces with grooves and the valleys between adjacent teeth thereof being provided with a rib between the flat faces therein and adapted to co-operate with corresponding grooves and ribs on the other die member and the sides of a tooth of each die member being provided with a deflecting punch and with a deflecting recess adapted to co-operate with a deflecting recess and punch of the other die member, said deflecting punches being constructed to engage the outer part of the side wall of a corrugation on said strip and tear the same before reaching the inner part of the same.

5. A machine for preparing strips of metal comprising two die members, each member having a plurality of V-shaped die teeth adapted to engage between adjacent teeth of the other die member, the opposite ends of the summits of the teeth of each member having flat faces and the valley between adjacent teeth also having flat faces and adapted to co-operate with the corresponding flat faces of the other member and the summits of each tooth on one member being provided between the corresponding flat faces with grooves and the valleys between adjacent teeth thereof being provided with a rib between the flat faces therein and adapted to co-operate with corresponding grooves and ribs on the other die member and the sides of a tooth of each die member being provided with a deflecting punch and with a deflecting recess adapted to co-operate with a deflecting recess and punch of the other die member, said deflecting punches being constructed to engage the outer part of the side wall of a corrugation on said strip and tear the same before reaching the inner part of the same and said deflecting punches and recesses being provided only with longitudinal cutting edges.

6. A machine for preparing strips of metal comprising two die members, each member having a plurality of V-shaped die teeth adapted to engage between adjacent teeth of the other die member, the opposite ends of the summits of the teeth of each member having flat faces and the valley between adjacent teeth also having flat faces and adapted to co-operate with the corresponding flat faces of the other member and the summits of each tooth on one member being provided between the corresponding flat faces with grooves and the valleys between adjacent teeth thereof being provided with a rib between the flat faces therein and adapted to co-operate with corresponding grooves and ribs on the other die member and the sides of a tooth of each die member being provided with a deflecting punch and with a deflecting recess adapted to co-operate with a deflecting recess and punch of

the other die member, said deflecting punches being constructed to engage the outer part of the side wall of a corrugation on said strip and tear the same before reaching the inner part of the same and said deflecting punches and recesses being provided only with longitudinal cutting edges and the ends of said deflecting punches being rounded.

- 10 7. A machine for preparing strips of metal comprising two die members adapted to receive a strip of metal between them and form laterally projecting wings thereon, and

evening means which receive said strip from said die members and operate to press said wings back uniformly, said evening means comprising two plates spaced apart and adapted to receive said strip between them, and means for adjusting one of said plates toward and from the other comprising a push screw and a pull screw mounted on a fixed support and engaging said movable evening plate.

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