

Feb. 15, 1949.

A. W. HALLBERG
METHOD OF PRODUCING DIES FOR EXTRUDING
EXTERNALLY-FINNED TUBES

2,461,640

Filed Nov. 29, 1946

2 Sheets-Sheet 1

Fig. 1.

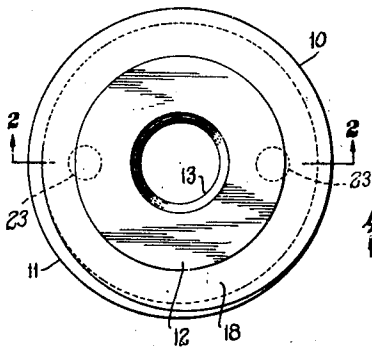


Fig. 2.

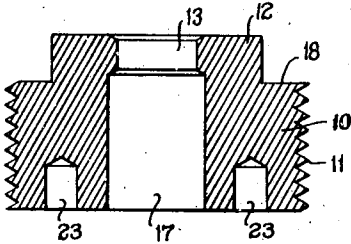


Fig. 5.



Fig. 3.

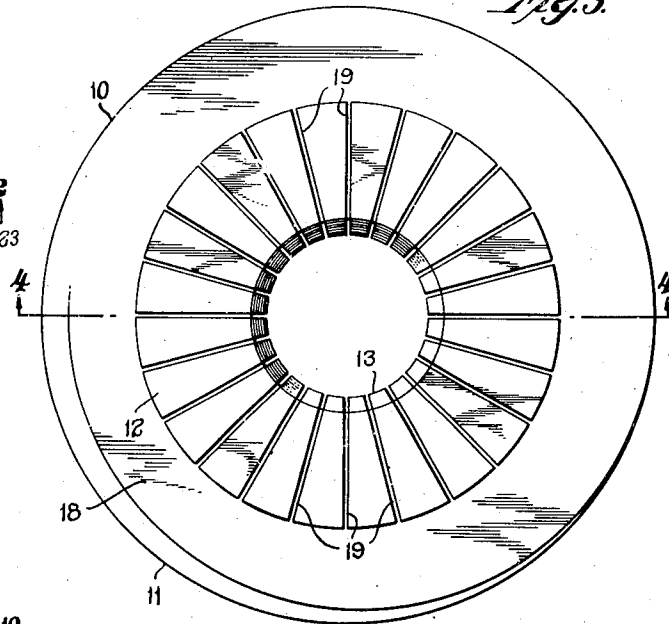


Fig. 4.

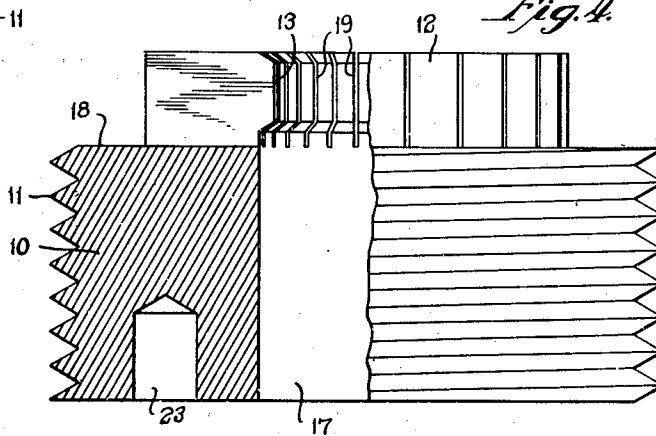
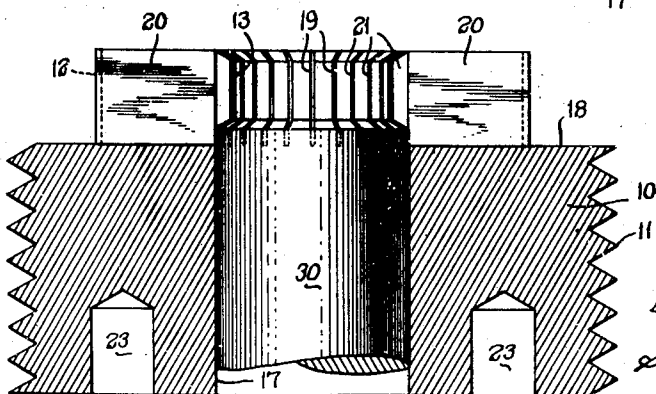


Fig. 6.



Inventor
August W. Hallberg
Seymour, Carter & Nichols
Attorneys

Feb. 15, 1949.

A. W. HALLBERG
METHOD OF PRODUCING DIES FOR EXTRUDING
EXTERNALLY-FINNED TUBES

2,461,640

Filed Nov. 29, 1946

2 Sheets-Sheet 2

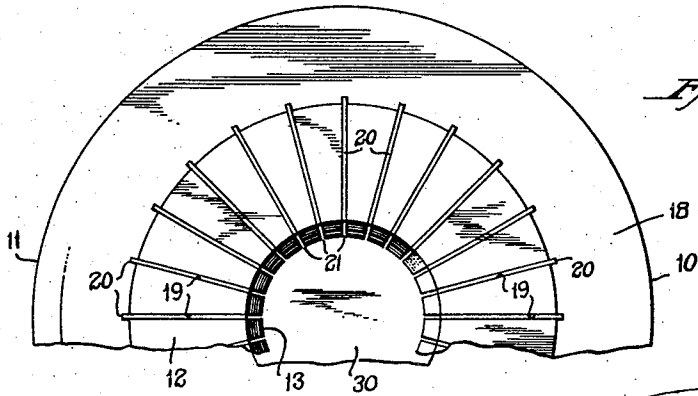


Fig. 7

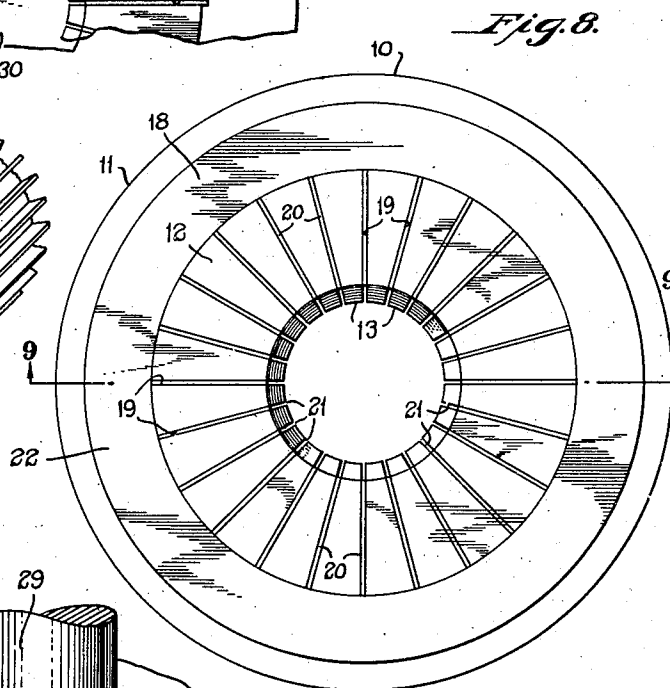


Fig. 8

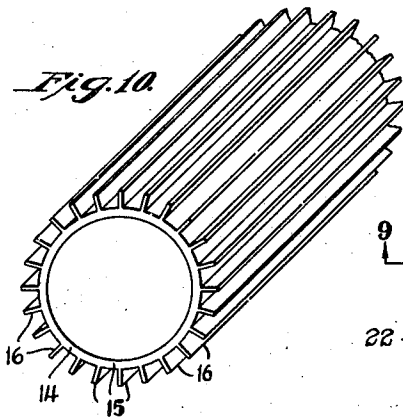


Fig. 10

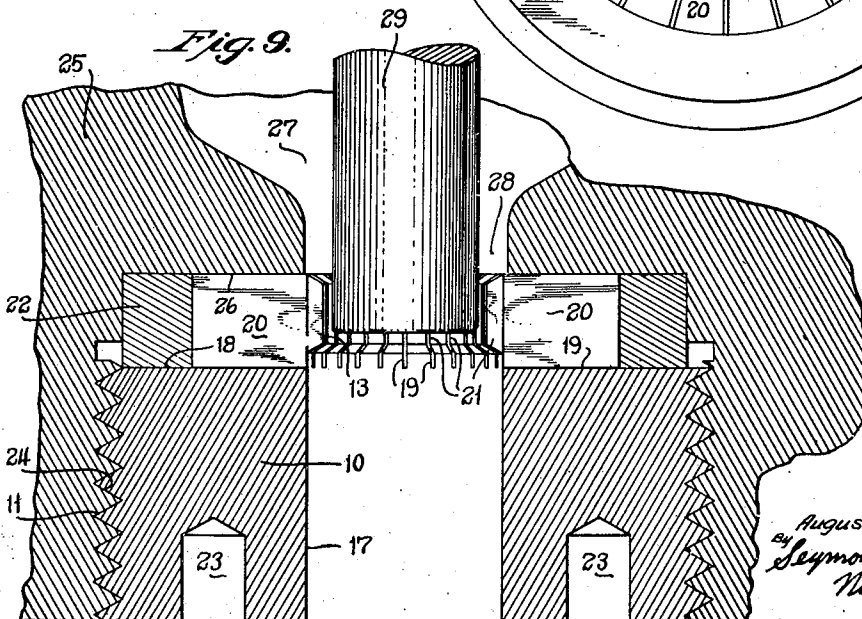


Fig. 9

Inventor
August W. Hallberg
by Seymour, Carl &
Nichols
Attorneys

UNITED STATES PATENT OFFICE

2,461,640

METHOD OF PRODUCING DIES FOR EXTRUDING EXTERNALLY FINNED TUBES

August W. Hallberg, Waterbury, Conn., assignor to Chase Brass & Copper Co. Incorporated, Waterbury, Conn., a corporation

Application November 29, 1946, Serial No. 713,160

2 Claims. (Cl. 76-107)

1

The present invention relates to improvements in extrusion-dies and relates more particularly to extrusion-dies for producing tubes having integral longitudinally-extending fins upon their outer peripheries. Such finned tubes are primarily useful as heat-exchange tubes but are available for a wide variety of other uses.

For heat-exchange purposes, a finned tube of the character referred to is most effective if it is provided with a relatively-large number of slender or thin fins rather than being provided with a lesser number of thicker fins. Heat-exchange tubes of the character first referred to, provide a much larger surface area for the transfer of heat and the advantages thereof are well recognized in the art.

Prior to the present invention, however, it has not been economically feasible to provide by extrusion methods the desired characteristics, especially on tubes of small diameters, since suitable extrusion-dies have been difficult and expensive to produce by conventional methods employing fragile broaches having thin or slender broaching-ribs thereon.

It is one of the main objects of the present invention, therefore, to provide a superior die for extruding externally-finned tubes and which may be produced at a low cost for manufacture.

Another object of the present invention is to provide a superior die of the character referred to which is both accurate and durable in use.

With the above and other objects in view, as will appear to those skilled in the art from the present disclosure, this invention includes all features in the said disclosure which are novel over the prior art.

In the accompanying drawings, in which certain modes of carrying out the present invention are shown for illustrative purposes:

Fig. 1 is a view of a partially-completed die-body suitable for carrying out the present invention and looking toward the inner or upper end thereof;

Fig. 2 is a transverse sectional view taken on the line 2-2 of Fig. 1;

Fig. 3 is a view similar to Fig. 1 but on a larger scale and showing the die-body after the same has been provided with an annular series of blade-receiving grooves;

Fig. 4 is a view partly in side elevation and partly in transverse section taken on the line 4-4 of Fig. 3;

Fig. 5 is a perspective view of one of the multiplicity of blades suitable for insertion into the blade-receiving grooves shown in Figs. 3 and 4;

Fig. 6 is a sectional view similar to Fig. 4, but

2

showing a gauge-plug inserted into the clearance-passage of the die-body and a plurality of blades respectively installed in the blade-receiving grooves of the die-body;

Fig. 7 is a broken view similar to Fig. 3, but showing the blades in place, as in Fig. 6;

Fig. 8 is a view similar to Figs. 3 and 7, but showing the structure after the projecting-ends of the blades have been trimmed off and a retaining-ring has been mounted around the blade-mounting neck of the die-body to back up and retain the blades against radial outward movement;

Fig. 9 is a central-longitudinal sectional view through the completed die-structure, taken on the line 9-9 of Fig. 8, but showing the said structure mounted in the lower end of an extrusion-cylinder, together with a mandrel which is extended into the extrusion-passage of the die-structure preparatory to extruding a longitudinally-finned tube of the character shown in Fig. 10; and

Fig. 10 is a perspective view of a portion of a longitudinally-finned tube which may be produced by means of the structure of the preceding figures.

For a better understanding of a preferred mode of carrying out the present invention, reference may first be had to Figs. 8 and 9 wherein a completed extrusion-die is shown, and to Fig. 10 which illustrates an externally-finned tube which may be produced by means of the present invention.

The completed extrusion-die chosen for illustration in the figures just referred to, includes a die-body generally designated by the reference character 10 and which is preferably formed of high-grade steel or other equivalent material. The said die-body is generally of cylindrical form and is provided upon its outer periphery with threads 11. The said die-body is formed at its inner or upper end with an integral axially-extending blade-mounting neck 12 preferably having a smooth outer periphery. The said neck is formed axially with an extrusion-passage 13 which has a diameter substantially corresponding to the external diameter of the body-portion 14 of an externally-finned tube generally designated by the reference character 15 and shown in Fig. 10. The said externally-finned tube 15 also includes a plurality of substantially-longitudinal fins 16 which are formed integral with and project substantially radially from the body-portion 14 of the tube 15.

In its main or lower portion, the die-body 10 is formed with a clearance-passage 17 which is coaxial with the extrusion-passage 13 and communicates at its inner end therewith. The diameter of the clearance-passage 17 is prefer-

ably such as to substantially correspond to the over-all diameter of the externally-finned tube 15, measured from extreme to extreme of its fins 16.

The formation of the blade-mounting neck 12 upon the die-body 10 results in the formation of a shoulder 18 at the junction of the said neck and the inner end of the die-body 10 proper, since the said neck has a lesser diameter than the remainder of the die-body.

Formed in the blade-mounting neck 12 of the die-body 10 is a multiplicity of blade-receiving grooves 19 all radiating, in the instance shown, from the central-longitudinal axis of the die-body 10 and equidistantly spaced from each other in a circumferential direction. At their inner ends, each of the grooves 19 intersects the extrusion-passage 13, as well as a portion of the clearance-passage 17. At their outer ends, each of the blade-receiving grooves 19 intersects the outer periphery of the blade-mounting neck 12.

The blade-receiving grooves 19 above referred to preferably have a depth, in a direction axially of the structure, corresponding to the length or height of the blade-mounting neck 12 so that the lower edges of the said grooves coincide with the surface of the shoulder 18 at the base of the said neck 12.

Respectively mounted with a tight drive- or shrink-fit in the blade-receiving grooves 19 of the blade-mounting neck 12, are a plurality of hardened steel plate-like blades 20 which are of substantially-rectangular form in the instance shown, as will be apparent by reference to Fig. 5 in particular.

The radially-inner edges of each of the blades 20 preferably coincide with the surface of the clearance-passage 17 in the die-body to thus leave the radially-inner portions of the grooves 19 vacant, to provide fin-forming passages 21 for the formation of the fins 16.

The respectively-radially-outer edges of the blades 20 preferably coincide with the outer periphery of the blade-mounting neck 12, and each of the said blades has a width in the direction of the axis of the structure such as to correspond to the length of the blade-mounting neck 12.

Applied with a force- or shrink-fit over the outer periphery of the blade-mounting neck 12, is a steel or other suitable retaining-ring 22 having a width in an axial direction corresponding to the height of the said blade-mounting neck. The inner periphery of the said retaining-ring provides a seat against which the radially-outer edges of each of the multiplicity of blades 20 engage, to thus be held against radially-outward displacement.

In its lower face, opposite the blade-mounting neck 12, the die-body 10 is preferably formed with a pair of diametrically-opposite wrench-receiving sockets 23 adapted to receive a spanner-wrench or other suitable tool by means of which the die-structure may be threaded into and unthreaded from an internally-threaded cavity 24 formed in the lower portion of an extrusion-cylinder 25. The upper portion of the cavity 24 is untreaded and is of a lesser diameter than the diameter of the main portion of the die-body 10. When tightly threaded into the cavity 24, the die-structure serves to seat the upper edges of its blades 20 and its retaining-ring 22 against the upper transverse wall 26 of the said cavity, all as is shown in Fig. 9.

In a manner well known in the art, the extru-

sion-cylinder 25 may be formed with a billet-chamber 27 having a constricted outlet-passage 28 at its lower end. Preferably the said outlet-passage is of a diameter corresponding or substantially corresponding to the extreme outer diameter of the externally-finned tube 15 measured to the extremity of its fins 16. Thus, under the arrangement just referred to, the wall of the outlet-passage 28 coincides with the radially-inner edges of the blades 20 and with the wall of the clearance-passage 17 in the die-body 10.

A mandrel 29 may be extended downwardly through the billet-chamber 27 so that its lower or outer end extends into and is centralized within the extrusion-passage 13 of the die-body 10, in a manner shown in Fig. 9. The diameter of the mandrel 29 is such as to provide the desired internal diameter of the body-portion 14 of the tube 15 of Fig. 10. The externally-finned tube 15 may have an internal diameter, for instance, of about $\frac{1}{8}$ ", an over-all external diameter of about $\frac{3}{4}$ " and a wall thickness of the body-portion 14 of about $\frac{1}{8}$ ".

Now, when a thick-walled tubular billet of copper or the like (not shown) is placed in the billet-chamber 27 of the extrusion-cylinder 25 with the mandrel 29 extending through its hollow interior, a suitable impact-ram may be utilized to force the said billet through the extrusion-passage 13 of the die-body 10 to thus produce the tube with the character shown in Fig. 10.

In the case of copper, it is preferred to first heat the billet to a red heat to facilitate the extrusion, though with more readily flowable materials, lesser heats may be employed or the material, where suitable, may be extruded at room temperatures.

The extrusion forces, of course, exert great strains upon the die-structure, but due to the fact that the blades 20 are clamped between the upper wall 26 of the cavity 24 in the extrusion-cylinder 25 and the bottoms of the blade-receiving grooves 19 in the die-body 10, no vertical or tilting displacement will occur. Radial displacement will not occur due to the fact that the radially-outer edges of each of the blades 20 are backed up by the inner periphery of the retaining-ring 22.

In producing the die-structure above described, it is preferred to first prepare a partially-formed die-body of the character illustrated in Figs. 1 and 2, wherein the die-body is complete save for the formation therein of the blade-receiving grooves 19 and the installation in the said grooves of the plurality of blades 20.

A thin circular saw may now be passed diametrically across the blade-mounting neck 12 while rotating in a plane substantially parallel with the axis of the said neck to form the equally-spaced blade-receiving grooves 19. In the instance shown, each blade-receiving groove 19 has a similar groove located diametrically opposite and under such circumstances, a straight diametrical pass of a saw or its equivalent will produce two grooves at one setting. After producing a pair of diametrically-opposite grooves, the partially-completed die-body may be indexed around and subsequent pairs of grooves 19 produced until the annular series is completed.

A gauge-plug, such as 30 shown in Fig. 6, may be introduced into the clearance-passage 17 of the die-body 10 so as to overlap and close a portion of the radially-inner end of each of the blade-receiving grooves 19. The required number of plate-like blades 20 may be now respectively in-

serted into the blade-receiving grooves 19 until their radially-inner edges abut against the gauge-plug 30 and their respective lower edges firmly seated against the bottoms of their complemental grooves 19. Preferably and as shown, the blades are of such length in a radial direction as to project slightly beyond the outer periphery of the blade-mounting neck 12, in the manner illustrated in Figs. 6 and 7.

The mounting of the blades 20 in their respective blade-receiving grooves 19 may be accomplished in a wide variety of manners such, for instance, as by a force-fit and preferably after the said blades have been hardened and tempered. The blades 20 may also be inserted into the blade-receiving grooves 19 by heating the die-body 10 to a degree sufficient to cause a slight widening of its blade-receiving grooves 19, whereupon the blades 20, in a relatively-cooler condition, may be inserted so that when the said die-body cools, the said blades will be firmly gripped in place.

The structure, in substantially the condition shown in Figs. 6 and 7, may now be mounted in a suitable grinding fixture and the projecting outer ends of the blades 20 may be ground to flushness with the periphery of the blade-receiving neck 12 which latter also may be coincidentally ground to accurate size.

The retaining-ring 22 may now be installed over the blade-mounting neck 12 of the die-body 10 by first heating the said ring to expand it relative to the said neck and then applying it in place and permitting it to shrink into tight engagement not only with the periphery of the said neck but with the radially-outer ends of the said blades. If desired, a force-fit may be substituted for the shrink-fit referred to.

The upper surface of the structure now in substantially the condition illustrated in Figs. 8 and 9 may be ground so as to insure the flushness of the upper surface of the neck 12, the upper surfaces of the blades 20 and the upper surface of the retaining-ring 22.

The completed die-structure may now be inserted into the cavity 24 in the extrusion-cylinder 25 and utilized in the manner before described to produce externally-finned tubes 15, such as is shown in Fig. 10.

The radially-inner edges of the series of blades 20 provide the surface against which the respective outer edges of the ribs 16 of the tube 15 will be formed and gauged. Thus, in effect, the fin-forming passages 21 are bounded by the side walls of the radially-inner portions of the blade-receiving grooves 19 and the radially-inner edges of the blades 20.

Extrusion-dies for producing other than the round externally-finned tubes illustrated, may also be produced in accordance with the present invention.

In the manner above described, very slender fin-forming passages such as 21 may be provided without requiring the use of delicate broaches or the like.

The invention may be carried out in other specific ways than those herein set forth without departing from the spirit and essential characteristics of the invention, and the present embodiments are, therefore, to be considered in all respects as illustrative and not restrictive, and all changes coming within the meaning and equivalency range of the appended claims are intended to be embraced therein.

I claim:

1. The method of producing dies for extruding externally-finned tubes, which method includes the steps of providing a die-body, forming a longitudinal extruding-passage axially therethrough, forming a clearance-passage in said die-body for the fins of the tube to be extruded by boring a concentric counterbore in the lower end of said extruding-passage, forming a plurality of blade-receiving grooves in said die-body by cutting a plurality of transverse grooves across the upper end thereof to intersect both the inner sides of said extruding-passage and the inner sides of said clearance-passage, said transverse grooves lying in planes which are coextensive with and intersect the longitudinal axis of said die-body, mounting plate-like blades in each of said transverse grooves, inserting a plug-gauge into said counterbore into engagement with the lower ends of said plate-like blades to locate the inner edges of said blades radially outwardly with respect to the inner surface of said extruding-passage and substantially flush with the inner surface of said clearance-passage and then clamping a ring around the upper end of said die-body to provide seats for the outer edges of said plate-like blades.

2. The method of producing dies for extruding externally-finned tubes, which method includes the steps of providing a die-body, forming a neck-portion of reduced transverse dimensions on the upper end thereof, forming a longitudinal extruding-passage extending axially through said die-body and through the neck-portion thereof, forming a clearance-passage in said die-body for the fins of the tube to be extruded by boring a concentric counterbore in the lower end of said extruding-passage, said counterbore terminating within said extruding-passage in a plane above the juncture of said neck-portion with the body of said die, forming a plurality of blade-receiving grooves in said neck-portion by cutting a plurality of transverse grooves thereacross so that the bottom edges of said grooves are flush with the juncture of said neck-portion and the body of said die, said transverse grooves also intersecting both the inner sides of said extruding-passage and the inner sides of the upper end-portion of said clearance-passage and lying in planes which are coextensive with and intersect the longitudinal axis of said die-body, mounting plate-like blades in each of said transverse grooves, inserting a plug-gauge up into said counterbore to a position above the bottom edges of said grooves and into engagement with the lower ends of said plate-like blades to locate the inner edges of said blades radially outwardly with respect to the inner surface of said extruding-passage and substantially flush with the inner surface of the upper end-portion of said clearance-passage and then clamping a ring around the neck-portion of said die-body to provide seats for the outer edges of said plate-like blades.

AUGUST W. HALLBERG.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
567,606	McCool et al.	Sept. 15, 1896
837,707	Mouterde	Dec. 4, 1906
1,597,928	Simons	Aug. 31, 1926
1,836,821	Singer	Dec. 15, 1931
2,101,689	Richardson	Dec. 7, 1937