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METHOD OF MAKING TUBES

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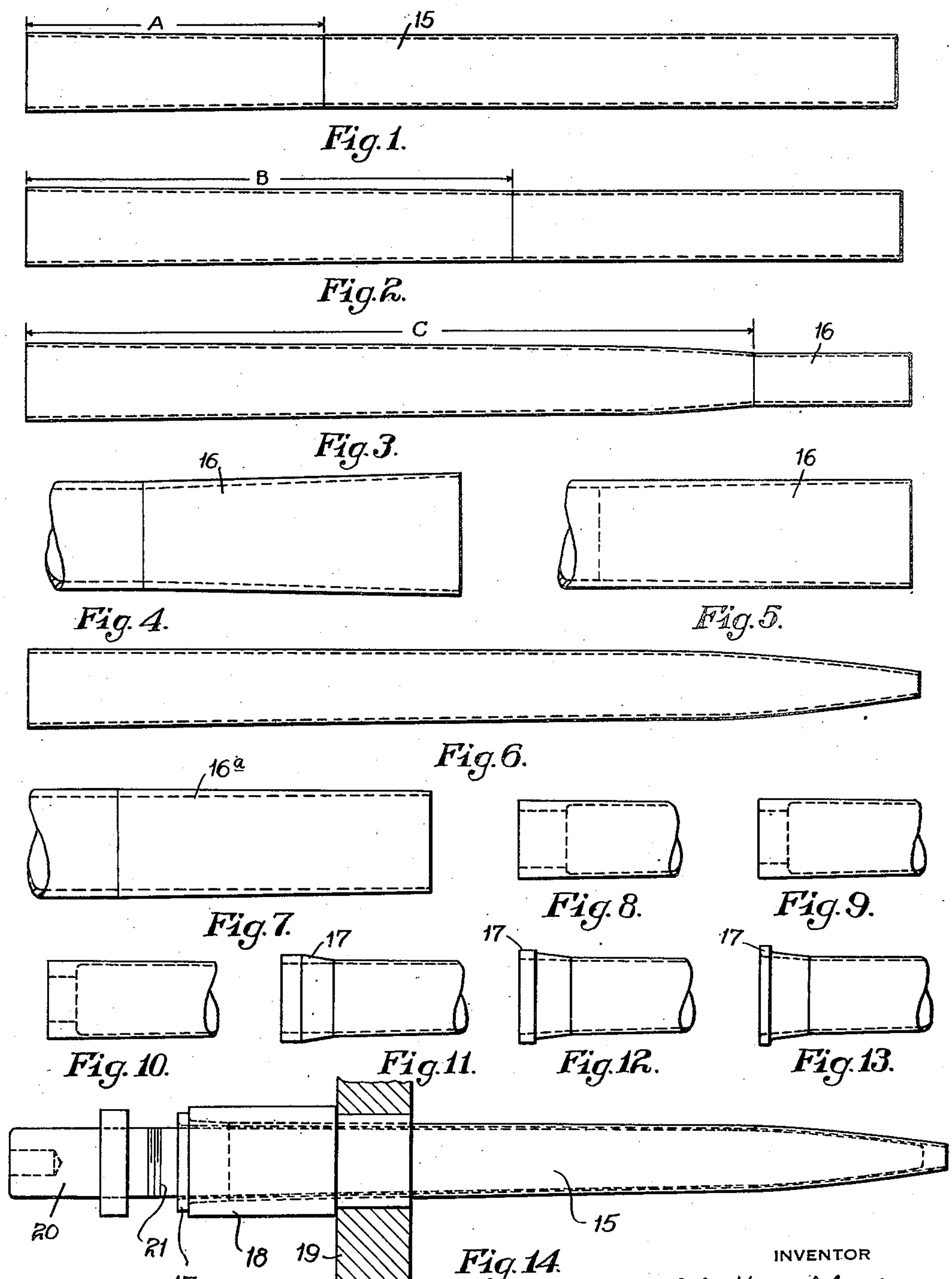

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UNITED STATES PATENT OFFICE

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METHOD OF MAKING TUBES

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My invention relates to a method of making tubes, and particularly to the making of tubes of very accurate dimensions and wall thickness, such as tubes specially formed to serve as blanks for aeroplane propellers.

One object of my invention is to provide a method of making a tubular blank of tapered form which is accurate to predetermined dimensions in the various portions thereof, and wherein there are no cracks or lines of weakness.

Another object of my invention is to provide a method of making a tubular blank of tapered form which is accurate to predetermined internal dimensions.

Another object of my invention is to provide a blank that is of such precise dimensions that it can be shaped to form aeroplane propellers that are accurately balanced.

Various of the steps followed in practising my invention are disclosed in the accompanying drawings, wherein Figure 1 is a view showing a tubular blank at an initial stage; Fig. 2 is a view thereof showing its form following a second step of my method; Fig. 3 shows its appearance at a later stage of operations; Fig. 4 is a view, on an enlarged scale, showing a preliminary shape imparted to the smaller end of the tube of Fig. 3; Fig. 5 is a view of the blank of Fig. 4 with its flared end reduced; Fig. 6 is a view showing the tube reduced to approximately its finally tapered form; Fig. 7 is a view showing a modification of the formation of the end portion of the tube shown in Figs. 4 and 5; Figs. 8 to 13 show successive steps in the shaping of the larger end of the tube, and Fig. 14 shows the final step of imparting the desired internal diameter to the tube.

While the blanks hereinafter are described as particularly designed for use in the forming of aeroplane propellers, it will be understood that they may be employed in the making of various other articles where a high degree of accuracy of dimensions and distribution of weight is required.

Aeroplane propellers are frequently made of steel or a steel alloy or other hard metal, and difficulty is experienced in shaping these harder metals to accurate desired contours, particularly while cold, without developing lines of weakness or cracks in the metal.

In Fig. 1, I show a blank 15 that may be of nickel steel alloy or other suitable metal. Starting with a cylindrical blank, the end portion A is subjected to a pressing operation in suitable dies to slightly flare and taper the same. A second operation is then performed upon the blank to slightly taper it throughout the portion marked B, in both cases the blank being flared slightly toward the left hand end thereof.

Fig. 3 shows the blank tapered still further, as indicated by the letter C, with that portion of the taper toward the small end of the tube being on longitudinally curved lines.

In Fig. 4, which is on an enlarged scale, the small end 16 of the tube of Fig. 3 is shown as expanded by a subsequent operation, with a tapering or flaring effect that is tapered toward the body of the tube and flared outwardly. This operation results in the thinning of the wall of the portion 16. Thereupon the said end portion 16 is reduced to its original diameter as shown in Fig. 3 (Fig. 5 being on an enlarged scale), the reduced wall thickness of Fig. 4 being preserved, such wall thickness, however, being tapered as shown in Fig. 5. The tapering of the wall at this point to the reduced wall thickness prevents the formation of longitudinal seams or transverse corrugations on the inside of the tube during cold or hot swaging or tapering, especially since the degree of taper at this point is considerably greater than at other points.

The blank having the pre-formed wall portion C and the reduced wall portion 16 is then heated and shaped by a tapered die, to the contour shown in Fig. 6.

Instead of reducing and tapering the wall portion 16 in the manner indicated by Figs. 4 and 5, I have shown in Fig. 7 another manner in which this portion, here designated as 16*a*, may be reduced, this method involving in the grinding or cutting away of metal from the periphery of this smaller end of the tube. The blank of Fig. 7 may then be heated and shaped on a tapered die to the contour of Fig. 6.

In either method of reducing and tapering the wall thickness of the smaller end of the tube, the result is that in reducing the smaller end of the tube to the tapering form shown in Fig. 6, there is better and more uniform distribution of the metal in such portion of the tube, which result would be impossible or difficult of attainment if the end 16 of the blank were simply compressed to the tapered form shown in Fig. 6. It will be seen that after each operation involving the steps shown in Figs. 3 and 6, the tube is elongated somewhat, by reason of the reduction in diameter of certain portions of the tube in producing the tapered shape.

The blank of Fig. 6 is then upset interiorly at its larger end by suitable dies and an upsetting member, in successive stages, as shown in Figs. 8, 9 and 10.

The successive stages of internal upsetting gradually increase the wall thickness of the larger end of the tube, the metal of the tube being compressed or forced inwardly without the formation of cracks or wrinkles. The thickened mass of metal thus formed interiorly of the tube may be readily transferred or expanded to form a thickened external flange 17 on the tube.

Ordinarily, external thickening and upsetting of a thin-walled tube of hardened metal, such as is here employed, results in the formation of cracks and wrinkles, which I find can be eliminated by first thickening and upsetting the metal internally, and then expanding the mass of metal radially to form an external flange.

Following the internal upsetting operations, suitable dies are substituted for the internal upsetting dies, and the mass of metal is expanded and forced outwardly to form the external tapering flange 17, as shown in Fig. 11. Subsequently, the tapering flange of Fig. 11 is flattened and compressed longitudinally of the pipe to the shape shown in Figs. 12 and 13, in successive stages.

In most instances it will be found desirable to anneal the blank before expanding it by a mandrel 20, so that it will have the necessary hardness and need not again be annealed or heat-treated after it has been shaped by the mandrel.

The blank of Figs. 1 to 13 is inserted through a tubular holder member or block 18 and a supporting member 19, with the flange 17 in abutting engagement with the end of the block 18. The tapered mandrel 20 is then inserted into the tube and is forced into the tube 15 to effect a final expanding operation and to bring the interior of the tube throughout its length to the exact internal diameter desired for the completed blank. The distance which the mandrel 20 is inserted into the tube can be determined by a gage mark or marks 21. The mandrel will preferably be coated with a lubricant, to reduce friction thereof with the tube.

All subsequent operations on the tube are performed on its exterior surface, and it is therefore highly important that the internal dimensions thereof be quite accurate in order to produce truly balanced blades. The tube, previous to its final expansion by the mandrel 20, preferably has its interior diameter slightly undersize, say $\frac{1}{32}$ inches, so that there will be sufficient expansion by the mandrel 20 to assure all the metal of the tube taking a permanent set, and insuring accuracy of internal dimensions and smoothness of internal walls.

The tube may be of various wall thickness, and as an example of the gage of the metal with which the foregoing operations may be conducted, the blank of Fig. 1, may have an initial wall thickness of approximately .165 inches, while the wall thickness of the tube will be approximately maintained throughout the operations on the blank except for the temporary thinning of the smaller end of the blank as in Figs. 4 and 7, and for the thickening of the other end of the blank as in Figs. 8 to 13.

After expansion of the tube by the mandrel 20, the mandrel is withdrawn therefrom, and the outer surface of the tube is ground to bring it to the exact over-all dimensions, and this grinding may be such that the wall thickness tapers toward the small end of the tube, since so great thickness of metal is not required at such end as at the base or large end of the tube. The internal diameter of the tube being precisely formed by the mandrel 20, it is a simple manner to so grind the exterior surface thereof as to provide the desired wall thickness and proper distribution of weight.

The small end of the tube is closed by a spinning operation, whereupon the tube constitutes a completed blank ready for shaping to propeller form as by performing a squeezing operation thereon, as between upsetting dies to flatten it somewhat or to give it a generally oval shape in cross section.

I claim as my invention:—

1. The method of making propeller blanks of tubes having a hardness approximating that of nickel steel alloy, which comprises forming a tube to tapered form with an internal diameter slightly less than that desired for the completed blank, forming an interior flange at the larger end of said blank, expanding the metal composing such flange to form an exterior flange, and introducing a tapered mandrel into the blank to slightly expand the same.

2. The method of making propeller blanks of tubes having a hardness approximating that of nickel steel alloy, which comprises forming a tube to tapered form with an internal diameter slightly less than that desired

for the completed blank, forming an interior flange at the larger end of said blank, expanding the metal composing such flange to form an exterior flange, introducing a tapered mandrel into the blank to slightly expand the same, and grinding the exterior surface of the blank.

3. The method of making propeller blanks of tubes having a hardness approximating that of nickel steel alloy, which comprises forming a tube to tapered form with an internal diameter slightly less than that desired for the completed blank, forming an interior flange at the larger end of said blank, expanding the metal composing such flange to form an exterior flange, introducing a tapered mandrel into the blank to slightly expand the same, and spinning the reduced end of the blank to close said end.

4. The method of making tapered tubular metal blanks which comprises first expanding the metal at that end of the blank which is of reduced diameter when completed, contracting said expanded end, the said end being maintained of circular form in cross section during expansion and contraction thereof, and thereafter shaping the blank to its completed form.

5. The method of making tapered tubular metal blanks which comprises first thinning the metal at that end of a blank which is of reduced diameter when completed, contracting the said thinned end while maintaining it of circular form in cross section, and thereafter shaping the blank to tapered form throughout substantially its entire length, by a tapered die introduced internally of the blank.

In testimony whereof I, the said JOHN KENNETH JAMISON, have hereunto set my hand.

JOHN KENNETH JAMISON.