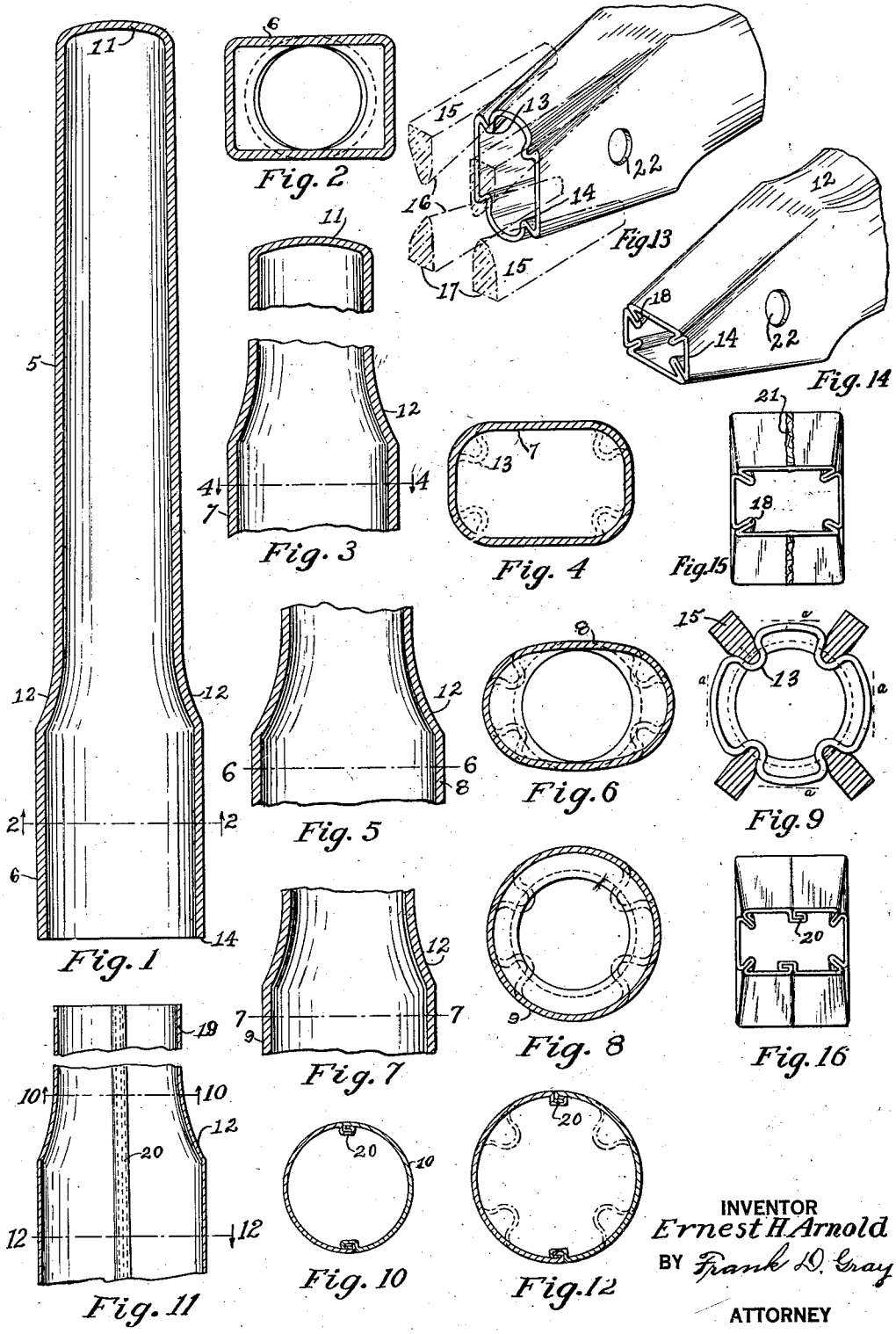
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METAL SPOKE AND ITS MANUFACTURE

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INVENTOR
Ernest H. Arnold
BY Frank D. Gray
ATTORNEY

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ERNEST H. ARNOLD, OF CLEVELAND, OHIO

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This invention relates to metal wheels and their manufacture, and concerns more especially the manufacture of integral spokes of the tubular form and particularly the fashioning of the inner ends of hollow metal spokes into the final form desired to fit the usual wheel hub and to cooperate with each other in such assembled relation in the hub. It is an object of my improved method and product, therefore, to manufacture a hollow metal spoke of circular form in cross section throughout the major portion of its length, but which will be shaped into other form—usually somewhat enlarged, at its inner end and then fashioned into the usual wedge-shape without separating any part of the tube from the outer portion and without destroying its relation as an integral part of the spoke unit.

It is a further object of my invention to manufacture a hollow metal spoke from metal plate, the final product being integral, and fashion the inner portion of the hollow spoke end into wedge-shaped formation without weakening the material in any point whatever, and indeed strengthening the hub end of the spoke as a complete unit.

It is a further object of my invention to reduce and simplify the operations required to manufacture the completed spoke, and especially to simplify the operations essential for fashioning the hub end of the spoke, and thus to decrease the expense of manufacture of the finished wheel.

With these and other objects in view, my invention consists of the operations, methods and products described in the specification, recited in the appended claims, and illustrated in the accompanying drawings, in which:—

Figure 1 is a central, longitudinal section of a one-piece metal product for producing a spoke;

Figure 2 is a transverse section taken on the plane indicated by the line 2—2 of Fig. 1;

Figure 3 is a sectional view similar to that of Fig. 1, of a modified form of inner end thereof, parts being broken away to reduce space;

Figure 4 is a transverse section taken on the line 4—4 of Fig. 3;

Figure 5 is a longitudinal section of the mid part of a modified form of spoke;

Figure 6 is a transverse section taken on the line 6—6 of Fig. 5;

Figure 7 is a view of another modification;

Figure 8 is a transverse section taken on the line 8—8 of Fig. 7;

Figure 9 is an end view of the hub portion of the spoke shown in Fig. 8 with an illustration of the tucking elements applied to the material;

Figure 10 is a transverse section taken on the line 10—10 of Fig. 11;

Figure 11 is a sectional view similar to that in Fig. 3, of a seamed spoke upon which my improved operations of tucking the hub portion are being accomplished;

Figure 12 is a transverse section on the line 12—12 of Fig. 11;

Figure 13 is a perspective view showing the tucking operations being performed on the character of spoke element shown in Figs. 3 and 4;

Figure 14 is a perspective view of the completed operation of tucking as applied to the form of spoke element shown in Figs. 1 and 2;

Figure 15 is an end view of a spoke formed of welded sections and tucked-in as in the product of Fig. 14, and

Figure 16 is an end view of a spoke formed of seamed sections as from the form of product shown in Figs. 10, 11 and 12.

Referring to the drawings, the numeral 5 designates a hollow metal spoke product having in most cases one closed end 11 which is intended to be locked to the wheel rim, but the latter not being specially illustrated since it will not be claimed in this application. The inner or hub end 6 of the spoke element is open as shown in Fig. 1 and will be preferably non-circular more often substantially quadrilateral, and usually substantially rectangular as shown in section in Figs. 2 or 4.

In manufacturing my integral metal spoke, I shape the inner or hub end to enlarged and usually non-circular cross section as a preparatory step in forming the

wedge-shape contour for making effective and close the assemblage of the several spokes in the finished wheel. The hub end will therefore at first have the form of an enlarged tubular element having substantially equal size at its ends, as made clear in the view in Fig. 1. The following step in the formation of the wedge-shaped portion of the spoke consists, then, in reducing the size of one of these ends, and I prefer to do this without making any cuts or slits in the walls of such enlarged end, and also without making it necessary to the proper shaping of this part that the outer surface of said part shall lose its general appearance after the shaping step, and also that the shaping operation shall even strengthen the walls of the finished hub portion of the spoke to better resist the forces that act so powerfully against the normal position which the spoke ordinarily assumes.

To accomplish this final shaping of the hub end of the spokes of this form and material, I have discovered that it can be most effectively and most advantageously done by applying inward-pressing forces at the corners of elongated forms, as they result in a cross-sectional view of the hub portion of the spoke, such forces being applied at equidistant points if the cross section is circular, and at the points of greatest curvature when the section is substantially quadilateral or rectangular.

In Figs. 1, 2 and 14, the hub end 6 of the spoke element 5 is shown substantially rectangular in cross section, though the main body of the spoke is circular in cross section, the circular portion gradually shading into the form of the hub end at the point 12. It is to be understood that the forms shown in Figs. 1 to 9, 13 and 14 have been produced by shaping, from a flat metal sheet, thereby resulting in the closed end 11. This is explained to make clearer the nature of the operations performed on the product shown in those views.

The fashioning operations performed on the hub ends 7 of the spokes shown in Figs. 3 and 4, are quite similar to the others such as those performed upon the ends 8 of the spoke shown in Fig. 6. The steps of such shaping methods may also be performed upon the circular hub ends 9, shown in Figs. 7, 8 and 9, as will be made plain later in describing my method.

Referring now to the hub end 7 in Figs. 3 and 4, as a type for purposes of illustration only, my method of shaping the substantially rectangular end 7 which in Fig. 3 is shown as fairly uniform throughout its length, or at least to within a short distance of the point 12 where the main body 5 of the spoke begins, consists of applying inwardly-directed force at the several angles of the hub end 7 to fold or tuck inwardly at 13, portions of the metal at such angles or curves. It is, however, a matter of great importance that this tucking force is not applied at these angles at equal intensity throughout the length of the resulting fold or tuck, nor are such forces applied on a line parallel with the axis of the spoke or hub end, but, on the contrary, these forces are applied on lines which tend to separate at their ends nearer the closed end of the spoke 11, and would, if sufficiently produced in the opposite direction, intersect at a point or points beyond the open end 14 of the spoke.

In Fig. 13, I have shown in dotted lines what may be properly termed tines or forks 15 which are each approximately triangular in cross section. The apex 16 of the triangle serves as the elongated edge of the tine or blade which latter is designed to sink into the metal at the before-mentioned curves or angles of the hub end 7 to form the said tucks 13. These edges 16 face diagonally inward, the triangle base 17 being outward. The various tines or forks 15 are preferably supported upon a common element which will never contact the spoke member, since the four tines spreading slightly outward from their common support member, will have folded or tucked in the material of the spoke to the limit desired before the support reaches the spoke. It will, therefore, be seen that the longitudinal movement of the support with its tines carried thereby in the general direction of the axis of the spoke and toward the closed end of the latter, will result in a tucking-in operation on the material at the angles of the hub end.

Figs. 4, 6, 8 and 12 of the drawings show in dotted lines the folds that are about to be formed inwardly by the closer approach of the tines to each other as they move longitudinally of the spoke, until the outer ends of the tines 15 finally reach the extreme end of the enlarged or hub end where the spoke becomes gradually reduced at 12 to the body 5 of the spoke. In Fig. 13, the folds 15 are gradually reducing the end 7 to the wedge-shape required for assemblage in the hub of the wheel. In Fig. 14, the tucks 13 have been folded into plaits 18 within the enlarged spoke ends. These plaits being of greatest width at the open ends 14 and fading away to slight width at the points 12, the resulting end of the spoke will be wedge-shaped, as before stated.

It is to be noted that this folding operation may be used for folding in the material to form plaits having different widths throughout their length, when operating upon open-end spokes such as 19 shown in Fig. 11, as well as closed-end spokes, and that the same or kindred operations may be performed upon spoke ends though the spokes may be seamed at 20, as shown in Figs. 10, 11, 12 and 16; or welded at 21 as shown in Fig. 15 of the drawings.

Assuming, therefore, that the spokes have been shaped to the forms shown in Figs. 1—2, 3—4, 5—6, or 7—8—10—12—11 (as shown in full lines), the next step is the plaiting or tucking-in at the corners as above described in detail, to reduce the hub end of the spokes to the wedge-shape of Figs. 13 and 9; and also in dotted line illustration in other views, after which the sides are flattened by exertion of external pressure thereon as shown diagrammatically in the dotted lines *a* of Fig. 9. Such pressure externally reduces the hub end of the spokes to the rectangular shape in cross section, as shown in Figs. 14, 15 and 16.

The above-recited steps in my improved operations results in a finished spoke having, if desired, a closed outer end for attachment with the rim or felloe, and in every case, an open end 14 which is wedge-shaped, integral with the body part 5 or 19, seamless, if desired, and having at the corners strengthened portions at the plaits 18 which serve the long-desired function of giving the greatest resistance to the portions needing the greatest strength—thereby affording proper resistance to strains which exist at these particular points. My method, therefore, not only reduces the cost of production but at the same time strengthens the product.

It is to be noted that these spokes are not "drawn," in the ordinary sense of the term—the thickness of the material is substantially uniform throughout the product, both at the inner end, after the wedge-shape is produced, as well as at the outer or rim end where attachment is made with the rim or felloe. This fact places the greater importance upon the production of the plaits 18 to shape the hub end, for the purpose of creating greater resistance to strain at these points. My improved shaping steps referred to in this application has to do with tucking or folding operations which manipulate the material but do not stretch the same so as to result in thin portions of the fabric and consequent weakened sections of the product. It is by no means, therefore, without interest that the walls of the spoke and parts thereof, as illustrated in the drawings, are shown as having uniform thickness. This feature is the result of my new and improved method which embodies therein a series of shaping steps not including any stretching strains.

A further observation is here made as to the novel steps in the shaping of the material when finishing the operations in producing the spoke of the particular contour required to attach to the felloe band and to the hub. It is quite immaterial what the character of the plait shall take on the inner cavity of the finished spoke. The numeral 13 is used to merely designate the approximate shape the plaits will at first assume when the blades 15 or tines, or whatever agency is employed to exert inward pressure at the angles of the hub portion of the unfinished spoke, are pressed inwardly. Later when pressure is exerted at the planes indicated in Fig. 9 by the dotted lines *a*, these tucks or folds 13 will tend to close substantially to the form shown in the finally shaped hub ends, where such portions are designated 18. The exact shape these final plaits 18 will assume depends more or less upon the cross section of the form of hub end which is used, as will be readily understood. In any case, however, these plaits will strengthen whatever hub end in which they are formed.

The use of these plaits for shaping the metal in the hub ends of these seamless (if desired), and integral spokes, make possible wide variation of hub size and relative depth of hub wall, as well as wide variation in the number of spokes it may be desired to use. The mere variation in the depth of the plaits 18, which will depend, of course, upon the distance the inward pressure will be exerted at 13, will vary correspondingly the angle of the "wedge" of each spoke, and having once determined the said distance to use, the angle mentioned will be thereafter positively uniform, thus making quite ready and certain any desired adjustment of the shape of the "wedge" part of the spoke at the same time reducing the cost of manufacture while enabling production of a number of standard sizes and angles of the hub end of spokes with certainty of preservation of each type in exact formation designed they should have.

Spokes manufactured in the manner here described, are adapted to be assembled in the wheel hub in the same manner that other spokes of this rather standard shape are. For example, wooden spokes or metal spokes that are formed from metal portions having their edges welded or seamed together, would be assembled in the ordinary type of wheel hub in about the same way that my integral metal spoke would be secured. The holes 22 are provided for receiving therein the transverse bolts for securing the spokes in the hub, as usual.

What I claim and desire to secure by Letters Patent is—

1. A tubular metal wheel spoke having an open-end enlarged extension head rectangular in cross section, the corners of the head being reinforced by inturned plaits of its own material.

2. A tubular metal wheel spoke comprising a wedge-shaped hub portion having parallel and flat sides lateral of the wheel, the corners of the head being reinforced by inturned plaits of its own material.

3. A tubular metal spoke for vehicle wheels comprising a wedge-shaped head having parallel sides lateral of the wheel and flat in-

clined sides transverse of the wheel, the corners of the head being reinforced by inturned plaits of its own material.

4. A tubular metal wheel spoke having a wedge-shaped head having its four faces of continuous and integral metal stock, the inclined faces being each flat and smooth and the faces lateral of the wheel parallel, and the corners of the head being reinforced longitudinally by inturned plaits of their own material.

5. A tubular metal wheel spoke having a cylindrical body portion and a wedge-shaped head having its four faces of continuous and integral metal stock, the inclined faces being each flat and smooth, and the faces lateral of the wheel parallel, and the corners of the head being reinforced longitudinally by inturned plaits of varying width decreasing from the inner end of the spoke to the union of the head with the said body portion.

6. The method of making a metal vehicle wheel spoke comprising, providing a tubular body with an open-end enlarged extension therefrom on an axis in alinement with that of the said body, tucking in the material of the said extension on four lines spaced in pairs in said extension longitudinal of the spoke and to varying depth decreasing from the open end outwardly, and exerting inward pressure at the external surfaces of the extension between the lines of each pair and between the pairs and on substantially longitudinal planes to result in a hub end of the spoke having uniform width transverse of the wheel but tapered inwardly in the plane of the wheel.

7. The method of making an all-metal vehicle wheel spoke having a frusto-pyramidal hub end comprising, providing a tubular body with an open end enlarged extension therefrom on an axis in alinement with that of the said body, tucking in the material of the said extension on spaced lines where the corner edges of the frusto-pyramid are to be positioned longitudinal of the spoke and to varying depth decreasing from the open end outwardly to form internal plaits, and pressing inwardly the external surfaces of the extension between the said plaits and on planes two of which are parallel and other two of which intersect when produced, to close the plaits and result in a prismatic hub end of the spoke having opposite and flat parallel sides lateral of the wheel, but wedge-shaped in the plane of the wheel.

8. The method of making a tubular spoke comprising, shaping a thin metal plate into an elongated hollow form including a cylindrical body having a closed end and an open end, the latter being an enlarged extension of the cylindrical body, and having an axis alining with that of the cylinder, tucking in metal on four spaced lines in said extension longitudinal of the spoke and to varying depth decreasing from the open end outwardly toward the cylinder to form internal plaits or folds integral with the extension, and pressing inwardly the external surfaces of the extension between the said lines and on planes two of which are parallel and other two of which intersect when produced, to close said folds and result in a prismatic hub end of the spoke having opposite and flat parallel sides lateral of the wheel, but wedge-shaped in the plane of the wheel.

9. The method of making a metal wheel spoke comprising, providing a tubular body with an open-end tubular enlarged extension on an axis in alinement with that of the body part, tucking in the stock of said extension at spaced portions thereof on lines longitudinal of the spoke, forming plaits of said material of uniformly varying depth decreasing from the extreme end of the extension to zero where the extension becomes integral with the body part, and pressing the outer surfaces of the extension inwardly between said lines and in planes to reduce the said extension to wedge-shape in the plane of the wheel, and at the same time reinforce the extension at its angular portions without deforming the sides thereof.

10. The method of forming a wedge-shaped hub portion on a hollow metal tubular product having an enlarged extension rectangular in cross section, and in alinement with the axis of the product comprising, tucking in metal on four lines positioned at the corners of said extension longitudinal of the tube and to varying depth decreasing from the end of the extension outwardly toward the tube, and pressing inwardly the surfaces of the extension on planes two of which are parallel and other two of which intersect when produced, to close said folds and result in a prismatic hub end of the spoke having opposite flat parallel sides lateral of the wheel, but wedge-shaped in the plane of the wheel when the product is to be used as a spoke.

11. The method of making a metal vehicle wheel spoke comprising, providing a tubular body with an open-end enlarged extension therefrom on an axis in alinement with that of the said body, tucking in the material of the said extension on four lines spaced in pairs in said extension longitudinal of the spoke and to varying depth decreasing from the open end outwardly, and exerting inward pressure at the external surfaces of the extension between the lines of each pair and between the pairs to close the said tucked-in portions and result in a hub end of the spoke having uniform width transverse of the wheel but tapered inwardly in the plane of the wheel.

In testimony whereof I hereunto affix my signature.

ERNEST H. ARNOLD.