

March 23, 1937.

T. F. BRACKETT

2,074,453

METHOD OF MAKING WHEELS

Filed June 30, 1934

2 Sheets-Sheet 1

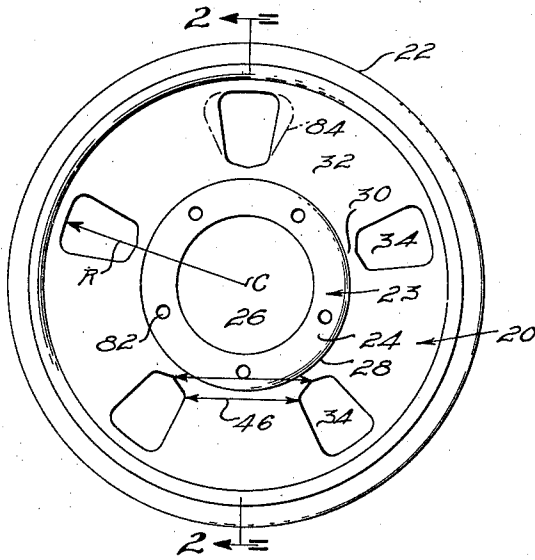


FIG. 1.

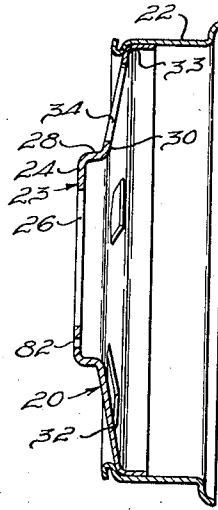


FIG. 2.

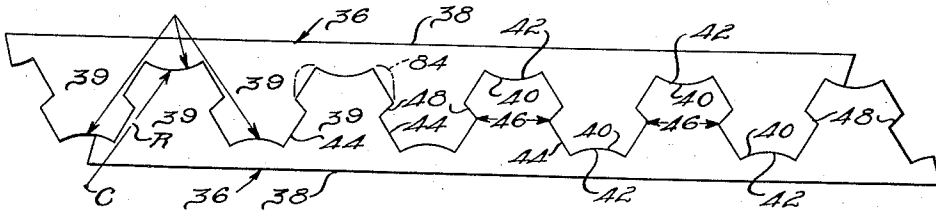


FIG. 3.

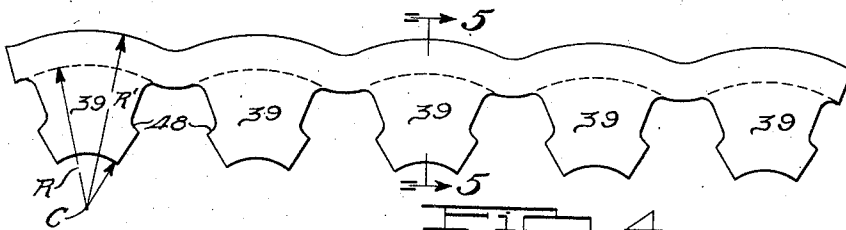


FIG. 4.

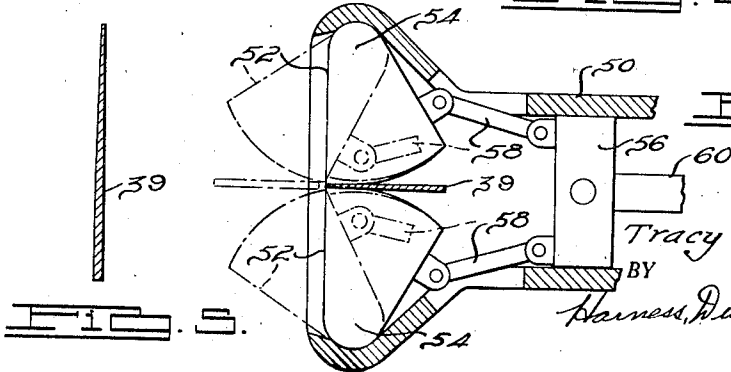


FIG. 5.

FIG. 6.

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2 Sheets-Sheet 2

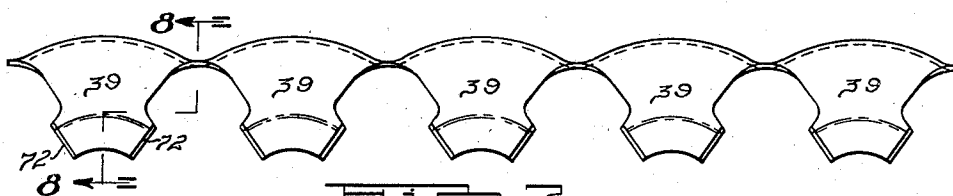


FIG. 7.

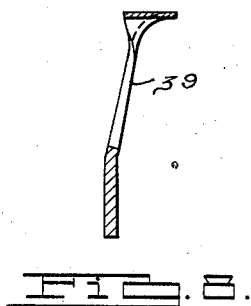


FIG. 8.

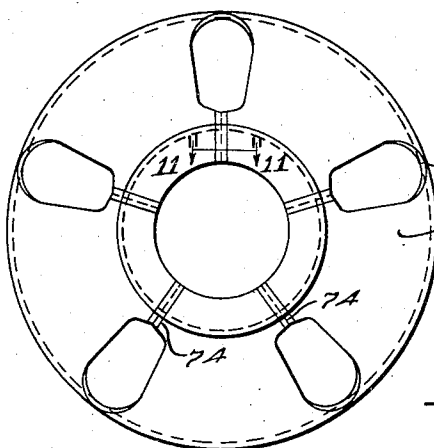


FIG. 9.

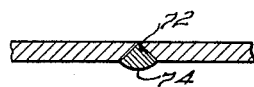


FIG. 11.

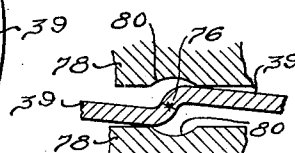


FIG. 12.



FIG. 13.

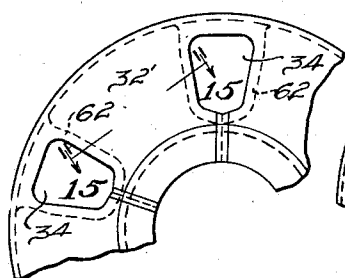


FIG. 14.

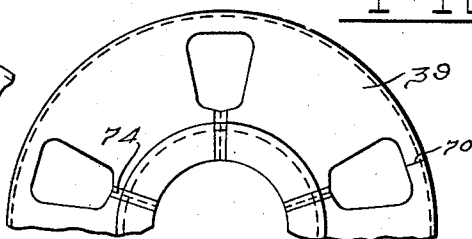


FIG. 10.

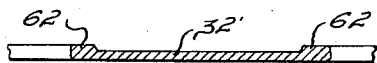


FIG. 15.

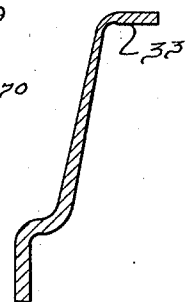


FIG. 16.

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UNITED STATES PATENT OFFICE

2,074,453

METHOD OF MAKING WHEELS

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Application June 30, 1934, Serial No. 733,176

17 Claims. (Cl. 29—159.03)

This invention relates to wheels and to a method of making same and has for its principal object the provision of a new and improved wheel of maximum strength for the weight thereof and the provision of a new and novel method of making the same from sheet or plate metal whereby a minimum amount of waste will result.

Objects of the invention include the provision of a wheel formed from sheet or plate metal and of gradually tapering thickness between the hub portion and the rim portion thereof; the provision of a wheel of disc-like character in which the thickness of the metal gradually diminishes from the hub portion thereof toward the periphery thereof and is provided with a peripheral flange of increased thickness for securement to a rim; the provision of a wheel of disc-like character having angularly spaced cut-out portions simulating spokes between them, the material of the wheel around the margins of the cut-out portions being thickened to give added rigidity to the structure; and the provision of a spoke wheel of disc-like character having certain novel features of construction.

Other objects of the invention are the provision of a method of making a wheel of disc-like character and provided with angularly spaced openings to simulate a wheel having a small number of spokes, including operating upon a sheet or plate of metal to provide a blank, including a plurality of spaced spoke portions interconnected at one end, modifying the blank, and then bending the blank into wheel-like form and welding co-acting edges of the blank together to form a wheel; operating upon a sheet or plate of metal to shear it into a pair of blanks having common shear lines and each including a plurality of spaced spoke portions interconnected at one end, then operating upon each of said blanks to form each of them into a wheel; the provision of a method for making a wheel comprising operating upon a sheet or plate of metal to form a blank including a plurality of spaced spoke portions interconnected at one end, operating upon said blank whereby to form portions thereof into substantially the desired circular formation desired in the completed wheel, and then bending the blank into a complete circular formation to form said wheel; the provision of a method of making a wheel comprising operating upon a blank of sheet or plate metal to provide a plurality of spaced spoke-like portions joined to one another at one end; operating upon the spoke-like

portions to modify their marginal conformation, and then bending said blank along the areas between said spoke portions and into wheel-like formation; the provision of a method of making a wheel comprising acting upon a sheet or plate of metal to form a blank including a plurality of spaced spoke portions connected together at one end only, the free ends of said spoke portions being formed to substantially the shape desired in the finished wheel, acting upon the connected ends of the spoke portions to modify their thickness and contour, bending the blank about the portions thereof connecting said spoke portions to bring said blank into wheel-like formation, and then welding abutting edges of the blank together; and the provision of a method of making a wheel comprising forming a blank from a sheet or plate of metal to provide a plurality of spaced spoke-like portions interconnected at one end only, flanging that edge of the blank along which the spoke-like portions are connected so as to bring the connected portions of the blank into a position approximately perpendicular to the plane of the spoke-like portions, and then bending the connected portions so as to bring said spokes into radially disposed relation with respect to a common center.

Other objects of the invention include the provision of a method of making a wheel comprising acting upon a sheet or plate of metal to form a blank including a plurality of spoke-like portions interconnected at one end only, operating upon the blank to modify the thickness of the metal from the free ends of the spoke-like portions toward the connected ends thereof, flanging the margin of the blank at the connected edge thereof, and then bending the blank along the areas thereof connecting the spoke-like portions to bring it into wheel-like formation; the provision of a method of making a wheel comprising acting upon a sheet or plate of metal of uniform thickness to form a blank including a plurality of spaced spoke-like portions interconnected at one end only, acting upon said blank to vary the thickness of the metal from the unconnected ends of the spoke-like portions towards the connected ends of such portions by flowing the metal toward such connected ends whereby to elongate such spoke-like portions, then bending said blank about those portions thereof connecting said spoke-like portions to bring the spoke-like portions into approximately radially disposed relation with respect to a common center, and then welding opposed edges of said blank together; the provision of a method

of making a wheel including operating upon a sheet or plate of metal of uniform thickness to form a blank including a plurality of spaced spoke-like portions interconnected at one end only, acting upon said blank to flow a portion of the metal thereof lengthwise of the spoke-like portions to vary the thickness thereof, flanging the margin of said blank along which the spoke-like portions are connected, and then bending the blank about the portions thereof connected to said spoke-like portions to bring the blank into wheel-like formation, and then welding the cooperating edges of said blank; and the provision of a method of making a wheel including operating upon a sheet or plate of metal of substantially uniform thickness to form a blank including a plurality of spaced spoke-like portions interconnected at one end only, operating upon the blank to decrease the thickness thereof from the free ends of the spoke-like portions toward the connected ends thereof, flanging the edge of said blank along which said spoke-like portions are connected, bending the blank about the portions thereof connecting said spoke-like portions to bring said blank into generally wheel-like formation, welding cooperating edges of the blank, and then subjecting said blank to a forming operation.

Other objects of the invention include the provision of a method of making a wheel comprising operating upon a sheet or plate of metal of substantially uniform thickness to form a blank including a plurality of generally spaced spoke-like portions interconnected along one edge only of the blank, operating upon the blank to flow metal of the spoke-like portions toward the connected ends of such portions whereby to taper the longitudinal sections of the spoke-like portions only and leaving that margin of the blank along which said spokes are connected at a thickness greater than that of the adjacent ends of said spoke-like portions, bending said margin out of the plane of the spoke-like portions, bending the blank about those portions thereof connecting said spoke-like portions to bring said spoke-like portions into approximately radially directed relation with respect to a common center, and then welding abutting edges of said blank together.

The above being among the objects of the present invention, the same consists in certain novel features of the construction, combinations of parts and steps or series of steps of operation to be hereinafter described with reference to the accompanying drawings, and then claimed, having the above and other objects in view.

In the accompanying drawings which illustrate suitable embodiments of the present invention and in which like numerals refer to like parts throughout the several different views,

Fig. 1 is a face elevational view of a five-spoke metal wheel of tapered spoke section, showing the tire mounting rim secured in place thereon.

Fig. 2 is a sectional view taken axially through the wheel shown in Fig. 1 as on the line 2—2 of Fig. 1.

Fig. 3 is a plan view of a sheet of metal indicating same severed into two blanks, either of which may be employed in accordance with the present invention to form a wheel of the character illustrated in Figs. 1 and 2.

Fig. 4 is a plan view of one of the blanks indicated in Fig. 3 after an initial operation thereon to vary the thickness thereof and to flow metal of the spoke portions toward the outer edges thereof to provide an additional area of metal.

Fig. 5 is an enlarged sectional view taken on the line 5—5 of Fig. 4.

Fig. 6 is a more or less diagrammatic, fragmentary, sectional view showing one arrangement of squeezing dies designed to flow the metal of the blanks indicated in Fig. 3 into the shape indicated in Fig. 4 and at the same time taper the thickness of the blank as indicated in Fig. 5.

Fig. 7 is a view similar to Fig. 4 but showing the blank as having that marginal portion thereof connecting the various spoke portions of the blank bent out of the plane of the spoke portions to form a flange and the spoke portions of which have been partially shaped.

Fig. 8 is an enlarged sectional view taken on the line 8—8 of Fig. 7.

Fig. 9 illustrates the blank as formed in Fig. 7 as bent to bring opposed edges of the hub ends of the various spoke sections into contact with each other, the ends of the blank into contact with each other and abutting edges welded together.

Fig. 10 is a fragmentary view similar to that shown in Fig. 9 but illustrating the same after it has been subjected to a final forming or shaping operation.

Fig. 11 is a fragmentary, enlarged, sectional view taken on the line 11—11 of Fig. 9 and illustrating the type of weld employed in such construction.

Fig. 12 is a more or less diagrammatic, fragmentary, sectional view taken transversely through abutting edges of cooperating spoke portions employing a modified process of welding such abutting edges together, and illustrating the type of electrodes employed in such welding operation.

Fig. 13 is a fragmentary, sectional view of the spoke portions indicated in Fig. 12 after they have been welded together.

Fig. 14 is a fragmentary view similar to Fig. 10 illustrating a construction in which the metal about the spoke openings has been thickened to give added strength to the structure.

Fig. 15 is an enlarged, fragmentary, sectional view taken on the line 15—15 of Fig. 14.

Fig. 16 is an enlarged radial section of one-half of a completed wheel of the type previously shown and in which the periphery of the wheel is formed with a rim or flange portion of greater thickness than the radially inwardly adjacent portion of the spokes.

Referring to Figs. 1 and 2 of the drawings, a wheel is indicated generally at 20 as having a tire-receiving rim member 22 secured to the periphery thereof in accordance with conventional practice. The wheel itself is shown as having a hub portion indicated generally at 23 having a radially directed portion 24 provided with a central opening 26 adapted to receive a conventional wheel hub member therein, an axially directed portion 28 of ring-like formation at the periphery of the portion 24, the edge of the portion 28 opposite the portion 24 being turned outwardly as at 30 in a generally radial direction in the same conic surface as the spokes 32. The spokes 32 are joined at their outer ends by an angular-shaped annular portion or fellow 33, the peripheral portion of which serves as a seat for receiving the tire rim 22 which is riveted, welded or otherwise suitably secured thereto. The present invention relates particularly to the wheel 20 as the rim 22 may be of any conventional construction and applied thereto in any conventional manner. It may be

noted that the portion 24 of the hub portion 23 is axially offset from the adjacent edge of the rim 22, this being for the reason that inasmuch as such wheel assemblies are intended for so-called dual mountings there must be sufficient offset of the hub portion and the rim so that there will be normal tire side wall clearance between the pairs of tires on a pair of dual wheels when mounted as such. Wheels of such degree of offset may, of course, be used as single wheels only and where a wheel is constructed in accordance with the present invention and designed for single mounting only, the axial relation of the hub and rim may be varied as desired from that indicated.

Articles of this same general form have heretofore been made but, as far as I am aware, in the past the wheel body has been made up as a disc wheel and in the same manner in which disc wheels are formed, that is from a square or octagonal plate, and then openings such as 34 have been punched or otherwise formed in them in order to effect the spoke portions 32. In the conventional method of first forming these wheels as a disc wheel and then punching of the openings 34 it will be apparent that a considerable loss of metal results in the manufacturing operation which results in a corresponding increase in cost of the manufacture of the wheel. In accordance with the present invention I am able to form such wheel from sheet or plate metal and by simultaneously forming two blanks, one interlocked with respect to the other as laid out on the sheet of metal from which the blanks are formed I am enabled to form such a wheel with substantially no loss of metal in its manufacture.

As illustrated in Fig. 3, each wheel blank in its initial form consists of a strip of metal indicated generally at 36 having a straight side 38 and from the opposite side of which projects a plurality of spaced laterally projecting portions 39 which go to make up the spokes 32 and segments of the hub portion 23 in the finished product, and the strip 36 eventually forms the rim 33 in the finished product. Each blank is provided with the same number of spokes as will appear in the finished wheel, in the particular instance illustrated 5, it being particularly understood that the present invention has for its object the provision of a method of forming wheels having a relatively small number of spokes, preferably five or six. As will be noted from an inspection of Fig. 3 the blanks are identical to each other and they are so proportioned and arranged that two of them may be interfitted and combined to form a solid sheet of equal width, the edges 38 in such case corresponding with the opposite edges of the sheet. This permits such blank to be stamped out of a sheet or plate of metal of the required width without leaving any scrap whatsoever.

This general method of forming wheel blanks is in itself generally not new as it has previously been suggested to punch out a pair of wheel blanks from a strip of metal and in which the blanks have more or less interlocking outlines but these previous designs have particularly applied to wheels of a type having many, small, or narrow spokes, with small hubs and relative large rim diameters, no attempt having been made to taper the thickness of the spoke section or create a disc-like appearance of the wheel when finished. Moreover, in these previous designs the strip portion of the blank which will eventually form the periphery of the wheel and which connects the spoke portions together has first been bent into a ring and its ends secured together and then

the spoke portions bent into generally radial conformation to effect the wheel. In such former designs if the outside diameter of the wheel was reduced and the hub area enlarged in keeping with present day practice and at the same time the number of spokes reduced to five or six, it would be impossible by the methods there suggested to get a smooth or perfect wheel due to the fact that the developed shape of a perfectly round wheel projected on a flat plane is that shown in Fig. 4 of the drawings of the present application. In other words, if a blank as shown in Fig. 3 were simply bent into a ring about a line parallel to the plane thereof until the two opposite ends abutted and such ends were secured together and it was then attempted to bend the spoke portions 39 into radial relation, it will be apparent that bending of the spoke portions would tend to flatten the ring over the extent of connection of the spoke portions with the strip portion 36 and thus distort the ring, or else tear the metal at the points where the spoke portions join the strip 36, or if done hot the edge 38 will draw up into arcs and not be straight. The method provided in accordance with the present invention is particularly designed to eliminate such deformation and/or tearing of the metal in the formation of wheels from blanks of the type described and shown.

Referring now to Fig. 3 which shows the blanks as initially formed from which wheels are made in accordance with the present invention, it will be understood that the edges 38 will form in the finished wheel the free edges of the rim portions 33 and that the metal in the edge zone 36 extending along the edges 38 as far inward as the arc 40, 42 will be the rim 33 when formed into a wheel and the projections 39 will be the spokes 32 in the final wheel previously described and segments of the hub portions 24, 28 and 30 previously described. The shear lines 44 common to both blanks at one end form a margin of the segment of the hub 23 on one side and on the opposite side a margin of an opening 34 in the finished wheel and the same is true at the opposite end of each line 44. The development of this shear line 44 so that the line 44 will be as long as possible and so that the distances designated at 46 will be as wide as possible, constitutes an important part of the invention.

In order to more clearly describe the invention and illustrate the method of predetermining the blank shown in Fig. 3 and the subsequent operation thereon in forming a wheel, the method followed in designing a five-spoke wheel to be used in connection with a conventional 20-inch by 5-inch pneumatic tire will now be described in detail. In such a case the lengths of the blanks shown in Fig. 3 are determined by the inside circumference of the wheel rim 22, which is fixed for the particular size of tire mentioned, namely, 62 inches, that is, the circumference of a 19 1/4 inch circle plus welding allowance. This length may be increased if desired but resort must then be had to shrinking the flange 33 (Fig. 2) so that it will assemble with the rim 22, or the length may be shorter, in which case the flange 33 will have to be stretched in order to properly assemble with the rim 22. Taking the length of the blank as 62 inches, it is evident that the blank will have five equal areas allotted to five spoke areas with spaces between the spokes. The material in the strip between the edges 38 is allocated to each blank, as shown in Fig. 3, so that the spaces between the spoke

portions 39 contain enough material to make the spokes of the opposing blank, but without waste. The reason for utilizing all of the metal is to make the distances 46 as large as possible because such distances represent the width of the spokes 32 in the final product and in 62 inches of length the amount of width available is barely enough, and no metal can be wasted. The shear lines between the blanks separate the spoke portions of the blanks and have therefore to follow an arbitrary profile best described as interlocking.

For a five-spoke wheel as considered in the specific example, the included angle between lines 44, Fig. 3, is seventy-two degrees, and as the lines 44 diverge from one end thereof and approach the center of the strip of metal there comes a point where the short connecting line 48 will be at right angles to both of the series of edges or lines 44. It is not desirable to go beyond this point because otherwise when the blank is shaped into a wheel and the edges 40 are welded together a point will be formed between them. It is evident that the edges 44 can have only a certain length and no more can be obtained without lengthening the blank which, of course, is undesirable from the standpoint of cost of production. For reasons of strength it is necessary that the spokes 32 be as wide as possible and the line 46 represents this blank dimension at the points where the spokes and hub portions join. A consideration of the layout shows that the only way to increase this dimension 46 is to increase the whole length of the blank and only a slight amount can be gained in this way for each spoke width.

Considering the thickness of the blank as $\frac{1}{2}$ of an inch, which is a conventional thickness for the hub portion of such wheels, it will be apparent that with the length determined the width of the blank cannot exceed a predetermined figure if the total waste is to be kept down to a point, that will result in a commercially economical product.

Referring to Fig. 3, it will be understood that the radius R struck from the center C, which corresponds to the true center of the wheel, establishes the condition that the edge 42 must be within an arc struck by the free end of the radius R or else no material will be available to form the felloe 33 in the finished wheel, and conforming to this condition for most blanks means, in view of their interlocking layout, that the edges 42 must coincide with the hub inner edges 40. Conforming to the weight conditions and to the dimensional conditions as outlined, means that the edges 38 are, in the specific example being considered, but eight inches apart, making the total weight of the foundation plate material approximately 44 pounds or 22 pounds for each blank.

The size of the center hole 26 in the finished wheel, as illustrated in Figs. 1 and 2, also determines the position of the coinciding edges 40-42 so that it is evident that to use all of the raw plate material and to get the maximum width for the spokes 32 and dimension 46 a definite method must be followed that will be practically the same for any wheels made by the method herein disclosed.

The purpose of the foregoing description of the method followed in laying out the blank is to bring out the difference between previously suggested methods of simply punching out blanks with interspaced projections to form

spokes and that of determining the outlines of the projections by considering the limitations of weight and thickness of hub metal, length of blank, etc. for wheels with particularly six spokes or less as above described.

When the centers C corresponding to the true center of the wheel are located and the radii R are laid out, it is found that the distance from the center C to the line or edge 42 is practically correct but the distance from the center C to edge 38 measured on the centerline of the spoke portion is far short of the true distance measured over the convex side of the wheel as shown in Fig. 2, although the distance from edge 38 to the line 40 is very nearly correct. The reason for all these apparent discrepancies is that a developed plan view of a spoke disc wheel would appear as indicated in Fig. 4 and, accordingly, the next step of operation is to subject the metal of the sheared out blank to pressure at proper points to cause the blank to increase in width particularly along the centerlines of the spoke portions. It is, of course, apparent that if the blank is thus widened the metal will decrease in thickness and that, if the dies which are employed for widening the blank are properly shaped, spoke sections will result that will taper in thickness from those portions of the blank which will form the hub areas toward those portions of the blank which will form the rim 33. Inasmuch as there is a definite limit set upon the total weight of the finished wheel, an arbitrary set figure put upon the thickness of the hub, and the length is fixed by the inside circumference of the rim to be received upon the wheel, the width of the punched blank must be narrow enough so that the weight figure falls within a small percentage of the finished wheel weight. This width determined in that manner definitely sets the width of the plate strip from which the blanks are punched, so that from the foregoing it is seen that if the desired purposes are to be accomplished, i. e., save weight and taper the spoke sections, no material can be lost along the shear line else there will not be enough left to make the wheel and attain strength enough to be of practical value.

Referring to Fig. 4, it will be noted that it represents one of the blanks shown in Fig. 3 after it has been operated upon to taper the longitudinal section of the spoke portion 39 and to provide sufficient metal in the outer edge portions thereof to compensate for the deficiency in metal along the longitudinal center line of the portion 39 as previously pointed out as existing in the blank as indicated in Fig. 3. In other words, the blanks illustrated in Fig. 3 are each operated upon to bring them into the condition illustrated in Figs. 4 and 5 wherein the longitudinal section of the spoke portion 39 is tapered as indicated in Fig. 5, the metal in the outer portions of the spoke portions 39 and strips 36 as illustrated in Fig. 3 being flowed toward the outer edge of the blank so as to effect an increase in the width of the blank centrally of the portions 39 and so that the outer edge of the blank 38 as viewed in Fig. 3 is caused to assume a more or less scalloped effect as indicated in Fig. 4 wherein the radius R' struck from the center of the wheel represents substantially the developed length of the wheel indicated in Figs. 1 and 2 from the axis of the wheel to the outer edge of the rim portion 33.

One form of apparatus for modifying a blank such as indicated in Fig. 3 to bring it to the shape and section indicated in Figs. 4 and 5 is illustrated

in Fig. 6 from which it will be noted that a suitable supporting frame is illustrated at 50 and as pivotally supporting a pair of opposed die members 52 for oscillatory movement about axes 54. Means including a cross head 56 connected to each of the dies 52 by means of links 58, and a shaft 60 adapted to connect the cross head 56 with a suitable source of power is provided for simultaneously oscillating the dies 52. The opposed faces of the dies 52 are eccentric to their oscillatory axes 54 and are so arranged that when a blank such as illustrated in Fig. 3 is placed between them and the dies oscillated as indicated in dotted line, the metal of the spoke portion 39 and edge strip portions 36, from the hub line 48 outwardly is squeezed and caused to flow outwardly so as not only to cause the thickness of the blank to be progressively reduced toward the outer edge but also to flow the metal of the blank outwardly and thus bring its shape to substantially that indicated in Fig. 4. As will be obvious to those skilled in the art, a die structure of the type shown and described, or other die structures provided for effecting the same result, may be modified so that the outer edge of the blank shown in Fig. 4 may be allowed to remain at its original or slightly reduced thickness so as to form a relatively thick rim such as that indicated at 33' in Fig. 16. On the other hand, the dies may also be modified so as to provide thickened portions along the margins of the spokes as indicated at 62 in Figs. 14 and 15 and which thickened portion would bound the openings 34 in the wheel and thus act to impart added rigidity to the wheel. Variations of the die structures to produce such effect as well as an article so effected is within the scope of the present invention.

After the blank has attained the form indicated in Figs. 4 and 5 it is then acted upon to bend the outer edge portion thereof connecting the various spoke portions 39, in the manner indicated in Fig. 8, that is, the outer edge of each spoke portion 39 which eventually will form a portion of the rim 33 in the finished wheel is curved so as to bring its outer edge into substantially perpendicular relationship with respect to the plane of the blank. It will be noted from an inspection of Fig. 8 that that portion of the edge strip joining the spoke portions 39 between the spoke portions 39 is bent almost wholly into perpendicular relationship with respect to the plane of the blank and does not conform to the curved outer edge of the blank as viewed in the longitudinal section through one of the spoke portions 39. It will also be noted, as indicated in Fig. 8, that during this flanging operation the spoke portions are preferably given an initial bend toward the shape they are to assume in the finished product. It is particularly important to note that the flange formed at the outer end of the spoke portions 39 over the width of such spoke portions is shaped to the same curvature and to substantially the same size as these portions will assume in the finished product as viewed in Figs. 1 and 2, the reason for this being that in bending the blank as illustrated in Figs. 7 and 8 to a circular or wheel formation substantially no bending of the outer end of the spoke portions 39 will be required and this effectively eliminates any stretching, buckling or tearing of the metal adjacent the line of juncture of the spoke portions and the rim portions as would occur in previously suggested constructions employing spokes approaching the width of the spokes herein employed.

The next step of operation is to take the blank illustrated in Figs. 7 and 8 and bend it to the shape indicated in Fig. 9 and in so bringing the blank to the shape indicated in Fig. 9 it will be apparent that it is necessary only to bend the metal connecting the various spoke portions 39 and, as illustrated in Fig. 8, this metal is substantially perpendicular to the plane of the spoke portions so that a substantially pure bending action upon such connecting pieces of metal occurs. The blank illustrated in Figs. 7 and 8 is bent over the area of the portions connecting the spoke portions 39 until the edges of the hub ends of the spoke portions 39 contact with the opposed edges of the adjacent spoke portions and until the extremities of the outer edges of the flanks are brought together as on the line 70 in Fig. 9. Preferably, the side edges of the hub ends of the spoke portions 39 in the blank illustrated in Fig. 7 are scarfed as at 72, and when the blank is bent into wheel shape as illustrated in Fig. 9 and the opposed scarf edges are brought into contacting or substantially contacting relation they are welded together as illustrated at 74 and best shown in Fig. 11.

Instead of scarfing the edges of the hub ends of the spoke portions 39 as at 72, a different method may be employed for welding the edges together in the manner illustrated in Figs. 12 and 13. As illustrated in said figures, instead of scarfing the edges as at 72, such edges are bent to an angle of substantially 45 degrees with respect to the plane of the spoke portions as at 76 in Fig. 12 and so that when the blank is bent into wheel shape such edges will abut each other as indicated in Fig. 12. Such abutting edges are then placed between suitable electrodes 78, preferably grooved as at 80 longitudinally of the line of contact between the edges and then a suitable electric current is caused to flow between the electrodes 78 and through the spoke portions 39, suitable pressure being simultaneously applied to the electrodes 78 so that the heating effect of the resistance to the passage of electric current through the abutting edges of the spoke portions 39 will cause them to become plastic and welded together and the pressure of the electrodes 78 will cause the bent edges to straighten out and to assume the welded section illustrated in Fig. 13. This method of welding edges of sheet metal or other parts together constitutes a part of the present invention but is obviously applicable to uses other than in the manufacture of wheels.

It will be noted that in the wheel as thus far finished and as illustrated in Fig. 9 the portions of the rim or strip joining the spoke portions and their outer edges is still, in the main, in perpendicular relationship with respect to the general plane of the wheel and only the end portions of such connecting portions are bent into the plane of the wheel disc. Also, that the offset relation of the hub portion with respect to the rim as desired in the final product illustrated in Figs. 1 and 2 is not yet attained. The diameter of the wheel as illustrated in Fig. 9 in the stage of completion as shown may also vary either one way or the other from that desired in the finished product. Accordingly, the next operation upon the wheel as shown in Fig. 9 is simply a forming operation for the purpose of bending in the outer edges of the rim portions connected to the outer ends of the spoke portions, and giving the wheel the proper diametrical size, and contour as viewed in a longitudinal section to the spokes. This op-

eration may be performed in accordance with any conventional practice and by conventional apparatus, and brings wheels to the form shown in Fig. 10. The holes 82 for reception of the usual hub studs (not shown) may now be drilled, the excess material along the line of weld removed, the inner and outer peripheries of the wheel trimmed and other finishing operations performed. At the same time, if the openings in the disc are not of the shape desired in the finished product the openings 34 may be enlarged and/or modified in shape or size, for instance, as indicated in dotted lines at 84 in Fig. 1.

From the above it will be apparent that by the method herein disclosed it is possible to construct a disc type of wheel having a small number of spokes and in which the spoke sections are tapered longitudinally to produce a wheel of maximum strength in proportion to its weight with substantially no waste of material from the blank from which it is produced. It may be noted that the raw material for a wheel produced as above described capable of carrying the same load as the same size of wheel produced in accordance with former practices weighs, in the particular size noted, substantially ten pounds less than those constructed in the conventional manner and, accordingly, these wheels are not only more economical to produce from the standpoint of weight of the wheel but additionally may be produced without the excessive amount of scrap necessitated in accordance with prior methods of producing the same types of wheels.

It will, of course, be understood that but one particular arrangement of parts has been shown and described as illustrative of the broad invention and that various modifications and changes will be apparent to those skilled in the art once the present invention is disclosed to them and, accordingly, formal changes may be made in the specific embodiment of the invention described without departing from the spirit or substance of the broad invention, the scope of which is commensurate with the appended claims.

I claim:

1. In the manufacture of wheels, the step of forming a blank for a wheel comprising operating upon a plate of metal and thereby forming a plurality of spoke portions interconnected at one end, and then operating upon said blank by flowing a portion of the metal in said spoke portions lengthwise of such portions.

2. In the manufacture of wheels, the step of forming a blank for a wheel comprising operating upon a plate of metal and thereby forming a plurality of spoke portions interconnected at one end, and then operating upon said blank by flowing a portion of the metal in said spoke portions lengthwise of such portions and thereby varying the thickness thereof.

3. In the manufacture of wheels, the step of forming a blank for a wheel comprising operating upon a plate of metal and thereby forming a plurality of spoke portions interconnected at one end, and then operating upon said blank by flowing a portion of the metal in said spoke portions longitudinally of such portions, and thereby tapering the thickness of such portions between the ends thereof.

4. In the manufacture of wheels, the step of forming a blank for a wheel comprising operating upon a plate of metal and thereby forming a plurality of spoke portions interconnected at one end, operating upon said blank and thereby tapering the section of said spoke sections between

the ends thereof, and then operating upon said blank and thereby forming it into a wheel shape.

5. In the manufacture of wheels, the step of forming a blank for a wheel comprising operating upon a plate of metal and thereby forming a plurality of spoke portions interconnected at one end, and then operating upon said blank and thereby increasing the width thereof and varying the thickness thereof.

6. In the manufacture of wheels, the step of forming a blank for a wheel comprising operating upon a plate of metal and thereby forming an elongated blank comprising a plurality of spoke portions interconnected at one end, then operating upon said blank and thereby forming the outer ends of said spoke portions to substantially the same curvature as they will assume in the finished wheel while said blank is in an elongated condition, and then forming said blank into circular form.

7. In the manufacture of wheels, the step of forming a blank for a wheel comprising operating upon a plate of metal and thereby forming a plurality of spoke portions interconnected at one end, then operating upon said blank and thereby increasing the width thereof and varying the thickness thereof, and then operating upon said blank and thereby forming the outer ends of said spoke portions to substantially the same curvature as they will assume in the finished wheel.

8. In the manufacture of wheels, the steps of forming a blank for a wheel comprising operating upon a plate of metal and thereby forming a plurality of spaced spoke portions interconnected at one end, operating upon said blank and thereby increasing the effective length of said spoke portions, and then forming the connected ends of said spoke portions to substantially the same size and shape as they will assume in the finished wheel.

9. In the manufacture of wheels, the steps of forming a blank for a wheel comprising operating upon a plate of metal and thereby forming a plurality of spaced spoke portions interconnected at one end, operating upon said blank and thereby increasing the effective length of said spoke portions by flowing the metal of said spoke portions longitudinally thereof and simultaneously varying the thickness thereof, and then forming the connected ends of said spoke portions to substantially the same size and shape as they will assume in the finished wheel.

10. In the manufacture of wheels, the steps of forming a planular blank comprising a plurality of spaced spoke portions each connected to its neighbor at one end by a connecting portion, operating upon said blank and thereby flanging the connected end portions of said spoke portions in accordance with the curvature of said end portions in the finished wheel and thereby positioning said connecting portions in substantially perpendicular relationship with respect to the plane of said blank, then bending said blank at said connecting portions only and thereby bringing the side edges of the unconnected ends of said spoke portions together and then securing said side edges relative to one another.

11. In the manufacture of wheels, the steps of forming a planular blank and thereby providing a plurality of spaced spoke portions and portions connecting said spoke portions at one end thereof, operating upon said blank and thereby increasing the length of said spoke portions and varying the thickness thereof, flanging the con-

nected ends of said spokes and bringing said connecting portions into approximately perpendicular relation with respect to the plane of said spoke portions, bending said blank over the lengths of said connecting portions only so as to bring the free ends of said spoke portions into contacting relation, and then permanently securing said free ends together.

12. In the manufacture of vehicle wheels having tapered thickness spokes of minimum section thickness in the area adjoining a rim flange, the steps of making these wheels including punching out a pair of blanks from a metal plate, said blanks having areas, to be formed into spokes, in the form of projections attached at one end to a band of metal to be formed into a flange for attaching a rim, the projections of one of a pair of blanks interlocking with the second of the pair of blanks so that a common shear line serves as a means of separation between said blanks in said plate, subjecting the constituent metal of each blank to pressure working causing the width of the blank to increase and the section thickness of the spoke projections to assume a tapered form, turning a rim flange on the ends of the spoke projections opposite the hub end, swinging the spoke projections so that the hub areas approach and finally abut, and permanently joining the abutting edges of the hub areas to form one hub area in the finished wheel.

13. In the manufacture of vehicle wheels of metal having six or less spokes of tapered thickness, the method of making said wheels including the steps of operating upon a plate of metal and thereby forming a pair of blanks each having a plurality of connected projections corresponding to the number of spokes required in the wheel, the sheared edge outline of said projections in one of said pair of blanks forming the sheared edge outline of the projections in the other of said pair of blanks, subjecting the constituent metal of each blank to pressure working and thereby causing the width of the blank to increase and the thickness to decrease in the form of a tapered section having minimum thickness in the areas in which the greatest increase in width takes place, turning a rim flange on the rim end of the spoke projections and curving the metal of the spoke proper into a shape coinciding with the shape required as a finished spoke in the finished wheel, swinging the spoke projections in a common conic surface so that the hub areas of the spoke projections approach one another and finally abut, permanently joining the abutting hub areas along the abutting edges of the hub areas into one hub area, and finally pressing the resulting product into the finished wheel form.

14. In the manufacture of vehicle wheels of metal having five tapered thickness spokes, the method of making said wheels including the

steps of punching out blanks approximately equal in length to the inside circumference of a rim, to be received on said wheel, to thereby provide blanks having five similar projections containing metal for the spokes and hub of the finished wheel, said projections being connected at one end and being formed in one of a pair of blanks from the material available in the spaces between the coinciding projections of the second of a pair of blanks with the outlines of the projections of both blanks a common shear line serving to separate the blanks, subjecting the constituent metal of each blank to pressure working and thereby forcing the width of the blank to increase and reducing the thickness of the spoke projections thereby forming progressively thinning thickness sections in each spoke projection from the free end thereof toward the opposite end, forming curved flanges on ends of said spoke projections to forms approximating that of the coinciding portions of the completed rim flange for said wheel, curving the metal connecting said spoke projections to one another thereby causing said connecting metal and that of said curved flanges to merge into one circular structure for use as the rim attachment flange of the completed wheel, and also causing the free end portions of said projections to swing into position for joining into one hub area, permanently joining adjacent radial edges of said free end portions to thereby form one wheel hub area, and pressing the partially fabricated wheel structure into the desired final wheel form.

15. In the manufacture of wheels, the method including the step of forming a blank for a wheel comprising operating upon a plate of metal and thereby forming a plurality of spoke portions interconnected at one end and then operating upon said blank by flowing a portion of the metal in said spoke portions lengthwise of said portions and thereby providing a blank structure of varying thickness in various portions thereof.

16. In the manufacture of wheels, the step of forming a blank for a wheel comprising operating upon a plate of metal and thereby forming a plurality of spoke portions interconnected at one end and then operating upon said blank by flowing a portion of the metal in said spoke portions only thereof lengthwise thereof and thereby providing a wheel blank having a rim portion of thickened cross section as compared to said spoke portions.

17. In the manufacture of wheels, the step of forming a blank for a wheel comprising operating upon a plate of metal and thereby forming a plurality of spoke portions interconnected at one end and then operating upon said blank by flowing a portion of the metal in said spoke portions and thereby providing spoke portions of increased thickness at the marginal edges thereof.

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