This invention relates to abrasive wheels, being particularly concerned with improvements in flexible abrasive wheels adapted for use in the finishing of metal parts.

Objects of the invention are to provide a wheel which may be readily axially deformed when driven by power means, in order that the abrasive surfaces upon the wheel may accommodate themselves to the shape of the object being worked upon; to provide laminated wheels made up of a plurality of abrasive disks such as emery cloth, so forming the disks that they will have a greater degree of resilience than would obtain if the disks were merely circular sheets of the emery cloth.

A further object is to provide an alternative type of abrasive wheel, composed of a plurality of laminated abrasive sheets, which will retain its utility until the sheets have worn to a very small diameter, the laminated disks being so arranged as to present a new surface of abrasive material as the periphery of the wheel wears.

A further object is to provide an alternative form of laminated abrasive wheel, capable of substantial axial deflection, wherein the individual disks comprising the wheel are substantially radially spoked, said disks being interlocked in such a manner that the rotationally leading edge of each spoke-like projection of a disk is covered by the trailing edge portion of the next adjacent spoke-like portion.

The devices of this invention are particularly adapted for use in smoothing formed sheet metal parts where concave depressions, or holes, are formed in the parts. The abrasive wheels are utilized in a portable electric drill or similar tool for smoothing and polishing the metal surfaces, and for removing burrs and sharp edges which result on the metal parts from stamping and other forming operations.

Further objects will be apparent from a reading of the subjoined specification and claims and from an examination of the accompanying drawings, in which similar numbers indicate like parts, and in which:

Fig. 1 is a side elevation of one form of the abrasive wheel of this invention;

Fig. 2 is an axial section through the disk elements of the wheel;

Fig. 3 is a plan of the wheel as viewed from the top of Fig. 1, showing the proper direction of rotation;

Fig. 4 is a view from the bottom of Fig. 1, showing the proper direction of rotation; Figs. 5 and 6 are plans of the two types of component disks comprising the wheel;

Fig. 7 is an elevation of a second embodiment of an abrasive wheel;

Fig. 8 is an axial section of the second embodiment, showing its utility in removing burrs from the edges of a hole punched in sheet metal;

Fig. 9 is an end elevation as viewed from the bottom of Fig. 7;

Fig. 10 is a side elevation of the wheel showing its use in connection with removing burrs from a hole punched in sheet metal;

Fig. 11 is a side elevation, partly in axial section, of a third embodiment of the invention; and

Fig. 12 is an elevation as viewed from the bottom of Fig. 11.

Referring first to Figs. 1 to 6, inclusive, we show an abrasive wheel so constructed as to have a high degree of flexibility for axial deformation. It comprises an arbor 15 having a threaded end 16 and an abutment washer 17, upon which, successively, is a large washer 18, four layers of abrasive disks 19, 20, 21 and 22 in laminated relation, a second washer 19, and a nut 23, the latter serving to clamp the assembly tightly in place against the abutment washer 17. The disks 19 to 22, inclusive, are of special and unique form, as shown in Figs. 5 and 6. The disks 19 and 20 serve to provide an abrasive surface facing toward the shank of the arbor 15, while the disks 21 and 22 provide an abrasive surface facing away from the shank of the arbor 15. The several disks are formed with radially offset slots, designated as 23 in Fig. 5 and as 24 in Fig. 6. Referring to Fig. 5, the form of disk shown is utilized for the disks 20 and 22 of the wheel, while the form of disk shown in Fig. 6 is utilized for disks 19 and 21 of the wheel. The offset slots 23 of Fig. 5 are cut so as to advance clockwise from their inner ends, while the slots 24 of the form of disk shown in Fig. 6 advance counter-clockwise from the slot inner ends. Referring now to Fig. 5, the slots 23 leave interslot portions 25 of abrasive material, each said portion having an acutely angled corner 26 and an obtusely angled corner 27. Now referring to Fig. 6, the slots 24 leave interslot portions 28 of abrasive material, each having an acutely angled corner 29 and an obtusely angled corner 30. To produce the disk combination 21, 22 of Fig. 3, a disk of Fig. 5 is superimposed upon a disk of Fig. 6, the corners 26 of the disk 27 being passed beneath the corners 23 of the disk 22, whereby the corner 29 and the corner 27 form trailing edges of abrasive material which overlap portions of the associated disks thereby, eliminating a loose-leading edge for each spoke-like
portion of the disk, avoiding any tendency for fraying. To form the disk combination 18, 29 of Fig. 4, a disk of Fig. 6 is superimposed on a disk of Fig. 5, the corners 22 of the disk 18 being tucked under the corners 26 of the disk 28, the corners 26 and 28 of respective disks thereby forming trailing edge portions overlapping the leading edges of the underlying disk portions.

The two disk assemblies of Figs. 3 and 4 are then placed back to back and assembled upon the arbor 15, thus providing opposed abrasive faces for the abrasive wheel with no sharp leading edge portions of either set of disks exposed to catch into work which is being smoothed. By virtue of the slots 23 and 24 in the disks, a substantial degree of axial flexibility is given to the wheel, so that the operator, in passing the wheel over work to be smoothed, may tilt the axis of the wheel in any desired direction and still hold a substantial portion of the wheel in contact with the work, also allowing the wheel to be run into otherwise relatively inaccessible depressions which may be formed in the work.

The form of abrasive wheel shown in Figs. 7 to 10, inclusive, though having the same basic features of axial flexibility which obtain in the first embodiment, is better adapted for smoothing the burrs from holes which may be punched in sheet metal. This wheel comprises a core of resilient material such as sheet rubber, and designated as 49, having oppositely facing abrasive disks 41 placed on opposite sides thereof. The disks 41 with the resilient disk 49 are assembled upon a mandrel 42 as by a screw 43, the central portion of the wheel assembly being reinforced by washers 44. As shown in Fig. 9, the assembly of disks is formed with a circumferential plurality of segmental cutouts 53, the cutouts extending a substantial distance inwardly from the periphery toward the center of the disk. The extent to which the slots may approach the center may vary for different sizes and types of disks, and in accordance with the character of work to be done. Generally, however, the slots should extend inwardly slightly more than half of the radius of the disk. When the wheel above described is rotated by an electric drill or other suitable power means, the edge of the wheel has a high degree of axial flexibility in both directions and, in fact, may be so deformed as to pass through a hole of substantially less diameter than the diameter of the wheel when it is in a planar attitude. Accordingly, Figs. 8 and 9 indicate the wheel being passed downwardly and upwardly, respectively, through an opening 48 punched in a metal sheet 47, whereby burrs such as 48 at the edge of the hole are efficiently and promptly smoothed. The action of a wheel of this type in rounding off the edges of the opening is very effective for, as the wheel is moved toward the opening, it is in a planar attitude and thus initially smoothes the edge of the opening substantially in the plane of the sheet 47. As the wheel is pressed inwardly, it deforms to smoothly round off the corner of the opening until it issues through the sheet and again assumes a planar attitude. Thereupon, the wheel is pulled upwardly through the sheet, as shown in Fig. 10, to effectively smooth the corners on the bottom surface of the sheet.

Figs. 11 and 12 show an alternative form of abrasive wheel which is well adapted for use in smoothing depressions formed in fabricated articles as, for instance, the depressions of aircraft cowling. This wheel comprises a mandrel 50 provided with an abutment washer 51 and a cupped washer 52. An abrasive disk 53 of relatively small diameter is then assembled on the mandrel, with the abrasive surface facing toward the mandrel, then a succession of disks 53 of increasing diameters are assembled, each having its abrasive surface toward the mandrel. Thereupon, a plurality of disks of consecutively decreasing diameter, these disks being indicated as 54, are assembled upon the mandrel, the whole series of laminated disks then being cemented to the mandrel by a screw 56. The distance from the inner face of the cupped washer 52 to the end of the mandrel, is made substantially coextensive with the thickness of the stack of disks 53, 54 and 55, so that, when the screw 56 is driven home, the central portions of the several disks are forced to a concave shape in accordance with the contour of the cupped washer 52. The resultant wheel assembly provides resilient working faces on the top, edge, and bottom of the wheel, so that the latter has great axial flexibility in adapting itself to virtually any kind of contour on the work upon which it is used.

Generally speaking, all three embodiments of the abrasive wheels shown have the common characteristic of being composed of laminated sheets or disks of conventional abrasive cloth whereby a flexible abrasive wheel is obtained. The several disks involved in the embodiments of the invention may be readily fabricated by die-cutting or manually cutting the initial sizes and sheets so that replacements of worn disks may be made in a minimum of time. The first and third embodiments of the invention have the added advantage that they may be used until the wheel is worn to very small size, due to the fact that, as the laminations wear, they uncover a fresh abrasive surface on the next disk, avoiding the necessity of constantly replacing abrasive disks as the disks become frayed, and as the abrasive material becomes either dull or worn. While we have described our invention in detail in its present preferred embodiments, it will be obvious to those skilled in the art, after understanding our invention, that various changes and modifications may be made therein without departing from the scope thereof. We aim in the appended claims to cover all such modifications and changes.

What is claimed is:

1. A flexible abrasive wheel comprising a pair of flexible abrasive disks each having a circumferential plurality of radially offset slots therein formed offset spokes, the spokes of respective disks being interlocked to provide an anti-rotational overlap by the spoke trailing edges of respective disks, over the next adjacent spoke leading edges.

2. A flexible abrasive wheel comprising a flexible disk having a plurality of uniformly radially offset slits extending from the circumference of the disk inwardly, a second disk having slits uniformly radially offset in opposition to the slits of the first disk, said disks being coaxial and interlocked, the oppositely offset spokes thereof, formed by said slits, being at the several slits to provide a plurality of spokes trailing edges each overlapping the leading edge of the adjacent spoke.

3. A flexible abrasive disk for abrading work applied to the disk face comprising an arbor, a disk thereon having inwardly projecting slots around its circumference retreating from the di-
recession of rotation forming rotationally retreating strips therearound, a second disk overlying the first disk having inwardly projecting slots around its circumference advancing into the direction of rotation forming rotationally advancing strips therearound, the corner of each rotationally advancing strip being tucked through a slot of the other disk in a manner such that all of the trailing edges of the rotationally advancing strips cover the leading edges of the rotationally retreating strips, and all of the trailing edges of the rotationally retreating strips cover the leading edges of the rotationally advancing strips.

4. A flexible abrasive wheel comprising a set of at least two flexible disks, each having a plurality of slits formed therein to define between the slits, spokes having radially offset portions, the spokes of the disks being interlocked to provide a plurality of exposed circumferentially spaced single trailing edge spoke portions, each overlapping the leading edge of the next adjacent spoke.

5. A flexible abrasive wheel according to claim 4, characterized by the use of a pair of sets of flexible disks, in superposed relation, the sets having oppositely outwardly facing abrasive surfaces, and having the trailing edges of respective spokes retreating from the direction of rotation.

FRANK MITSCANG.
JOSEPH MITSCANG.
JULIAN C. WANDER.