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W. H. WELCH

2,188,771

ELECTRODE

Original Filed Jan. 26, 1934

Fig. 1.

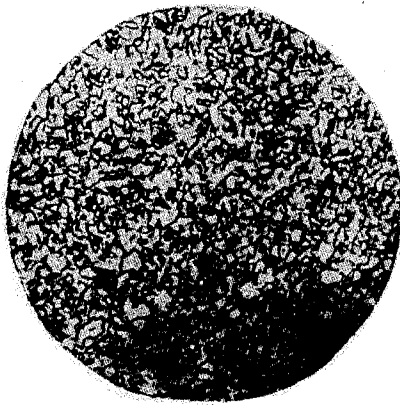


Fig. 2.

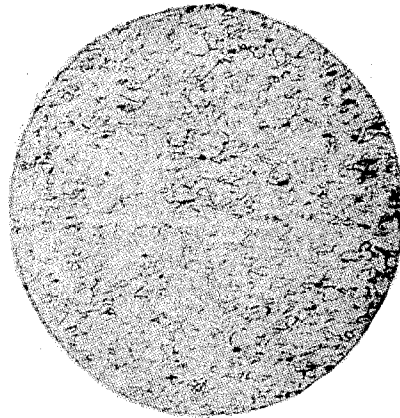


Fig. 3.

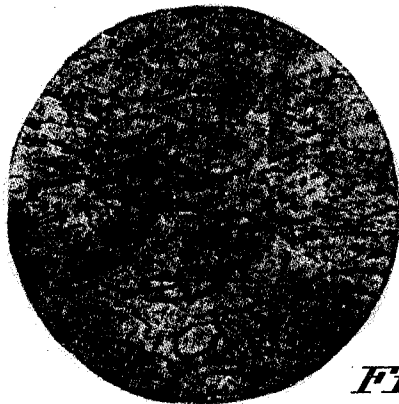


Fig. 4.

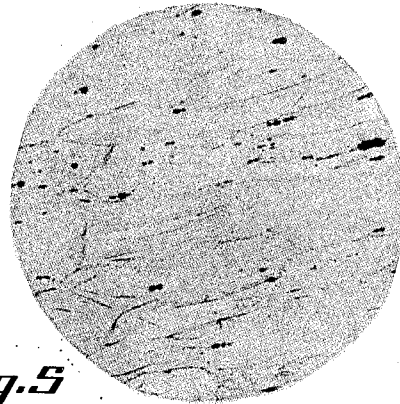
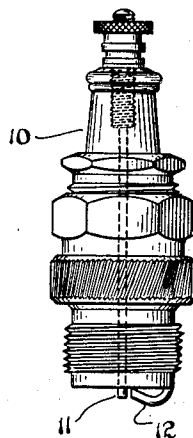


Fig. 5.



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UNITED STATES PATENT OFFICE

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ELECTRODE

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mesne assignments, to The Firestone Tire &
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Original application January 26, 1934, Serial No.
708,407. Divided and this application October
7, 1936, Serial No. 104,421

5 Claims. (Cl. 148—32)

This invention relates to electrodes, and more especially it relates to electrode wire that normally is subject to great heat, for example, the electrodes of the spark plugs of internal combustion engines.

Due to severity of conditions incidental to the use of spark plugs, the electrodes of ordinary spark plugs are subject to inter-granular corrosion and rapid disintegration or burning away, which require that periodic adjustment be made to preserve efficient sparking at the gap and which limits the life of the plug in service. Tests show that the ordinary spark plug electrode sponges out during use, and becomes larger in cross section due to inter-granular corrosion, with the result that the granules or crystals on the surface of the electrode lose their cohesion and flake off, thus causing rapid deterioration of the electrode.

The chief objects of the invention are to provide an improved electrode of the character mentioned, that will have relatively long life and that will resist corrosion. Other objects will be manifest.

In achieving the foregoing objects it was found that the structure, particularly grain size and shape of the grains of the electrode wire, was of primary importance, the composition of the alloy being secondary thereto. Best results were obtained where the grain size was relatively small both longitudinally and in cross section, apparently for the reason that since corrosion follows the inter-granular boundaries, the smaller grain size has greater resistance to attack.

This application is a division of my copending application Serial No. 708,407, filed January 26, 1934.

Of the accompanying drawing,

Figure 1 is a photomicrograph of a transverse section of the improved electrode, magnified 200 diameters;

Figure 2 is a view on the same scale as Figure 1, of a longitudinal section of the improved electrode;

Figure 3 is a view on the same scale as Figure 1, of a transverse section of an ordinary prior art electrode;

Figure 4 is a view on the same scale as Figure 1, of a longitudinal section of an ordinary prior art electrode; and

Figure 5 is a side elevation of a spark plug comprising the improved electrode.

It is known that small percentages of certain metals alloyed with nickel retard inter-granular corrosion. Preferably the alloy used in the im-

proved electrode is of the following composition:

	Per cent
Manganese-----	9.90-4.25
Silicon-----	.75-1.00
Cobalt-----maximum--	.25
Carbon-----do-----	.06
Sulphur-----do-----	.03
Iron-----do-----	.25
Nickel-----	Balance

The percentages may be varied slightly without appreciable detrimental effect. This alloy is substantially standard for the usual spark plug electrodes, and no novelty is claimed for it.

In the manufacture of electrode wire from metal of the foregoing composition, the alloy first is cast in ingot form, which ingot is then rolled into a bar and the latter drawn through successively smaller drawing dies until the desired wire size is reached. Between each pass or drawing operation the wire is annealed by heating at a temperature of 1200° F. to 1550° F., the time and temperature of annealing being carefully controlled to prevent grain growth. In order that the minimum grain size may be obtained in the finished product, the reduction in all drawing operations is very carefully controlled. Too great reduction in any of the passes would necessitate excessive annealing, which is objectionable in that it promotes grain growth. Experience has shown that about 25% reduction of the wire on each pass through the dies gives satisfactory results.

While the process may be carried out by the usual method of intermittent drawing and pot annealing, it is particularly adapted for a continuous method of drawing and annealing, the latter step being carried out in an elongated furnace through which the wire is continuously passed.

Just before the final drawing operation, the wire is given a special heat treatment which consists in "soaking" at the critical temperature of recrystallization, within a range of 1200° F. to 1600° F. according to a duration of treatment of 6 hours to 2 hours respectively in the case of treatment of a roll of wire by the pot annealing process, depending upon the amount of wire treated and the container in which it is placed. Preferably the wire is treated about 2 hours at 1550°. In the continuous annealing and drawing process a lesser time of heat treatment is required due to the relatively smaller mass presented and to the relatively larger heater

volume. It has been found that if the wire is heated below the proper temperature or for too short a time it would not be properly annealed, and if heated above this temperature or for too long a time a coarse grain would be produced due to combining of smaller grains into larger size particles.

The wire is finished in the usual manner and in final form presents a smooth, bright and clean surface free from slivers or flaws.

Referring now to the drawing, Figure 5 shows a spark plug 10 having electrodes 11 and 12, both of which preferably consist of the improved electrode wire. Microanalysis shows the improved electrode wire to be composed of grains of one one-hundredth ($\frac{1}{100}$) to one three-hundredth ($\frac{1}{300}$) the grain size of the ordinary electrode wire for the same purpose. The relative smallness of the grains of the improved wire as compared to the grains of prior structures will be apparent from a comparison of Figures 1 and 2 with Figures 3 and 4 respectively. In a grain count made on a photomicrograph of the improved electrode wire at 200 diameters, such as Figure 1, a two-inch diameter circle representing an area of 100 circular mils will contain at least 200 grains. Moreover, the grains of the improved wire are equi-axed, that is, the particle size is substantially the same transversely as longitudinally. It has furthermore been found that electrode wire treated by this improved process has its grain and crystalline structure in equilibrium so that further grain growth and recrystallization within the grain is inhibited

when the electrode wire is subjected to elevated temperatures.

The fine grained structure of the wire affords a smooth, bright finish thereon, and makes the wire more resistant to intergranular attack than a corresponding coarse-grained wire. The latter also would have a rough or pebbly surface. Actual tests have shown that the use of the improved electrode greatly prolongs the life of spark plugs in service.

Modification may be resorted to without departing from the spirit of the invention or the scope of the appended claims, which are not limited wholly to the specific construction shown or exact procedure described.

What is claimed is:

1. An electrode consisting mainly of nickel having a grain count of at least 200 in an area of 100 circular mils.
2. An electrode consisting of metal alloy that is mostly nickel, the grain size of said metal being one one-hundredth to one three-hundredth the normal size of the grains of said alloy.
3. An electrode wire consisting essentially of nickel, the grains of which are equi-axed.
4. An electrode consisting mainly of nickel having a grain count of at least 200 in an area of 100 circular mils, said grains being equi-axed.
5. An electrode consisting of metal alloy that is mostly nickel, the grain size of said metal being one one-hundredth to one three-hundredth the normal size of the grains of said alloy, said grains being equi-axed.

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