May 30, 1944. J. T. KELLEHER 2,349,825

METALLIC COMPOSITION AND ABRADING TOOL OF SAID COMPOSITION

Filed Sept. 26, 1942 2 Sheets-Sheet 1

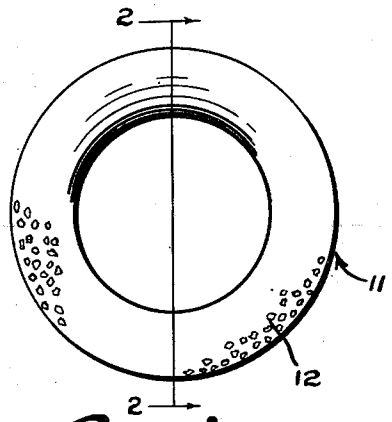


Fig. 1

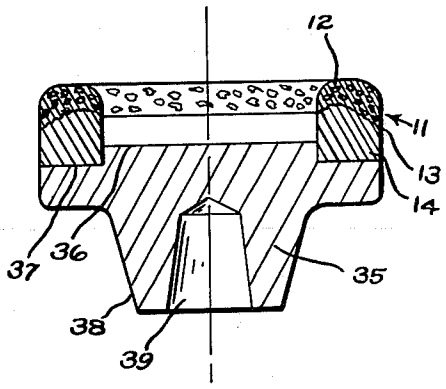


Fig. 2

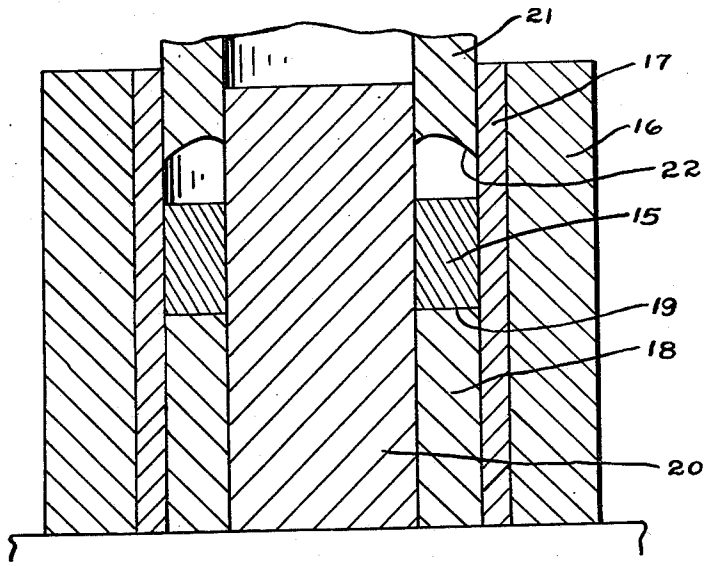


Fig. 3

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METALLIC COMPOSITION AND ABRADING TOOL OF SAID COMPOSITION

Filed Sept. 26, 1942 2 Sheets-Sheet 2

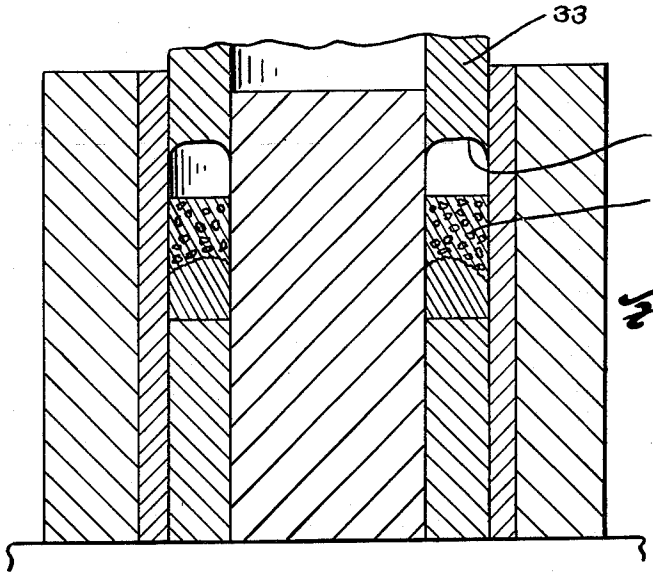


Fig. 4

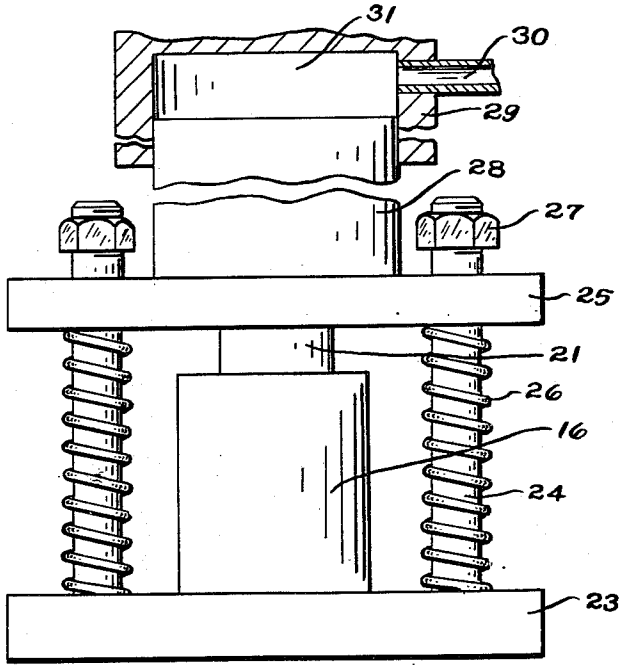


Fig. 5

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UNITED STATES PATENT OFFICE

2,349,825

METALLIC COMPOSITION AND ABRADING TOOL OF SAID COMPOSITION

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Application September 26, 1942, Serial No. 459,818

13 Claims. (Cl. 51—309)

This invention relates to improvements in metallic compositions and more particularly to metallic compositions for use in forming abrading tools and method of making the same.

One of the principal objects of the invention is to provide novel metallic compositions and abrasive charged tools of said compositions and methods of making the same whereby the particles of abrasive will be substantially uniformly distributed throughout the effective body portion of the tool and the bonding resulting from the sintering of the metals of said compositions will have a desirable resistance to wear and possess such holding action on the abrasive particles as to more positively insure their performing the full extent of their usefulness prior to becoming dislodged from the tool.

Another object is to provide tools of the above character with a backing support formed of sintered metallic particles or solid metals having solderable characteristics.

Another object is to provide novel means and method of forming an abrading tool with a main effective body portion comprising a mixture of particles of abrasive and particles of metal normally having non-solderable characteristics heat joined to provide a support for said abrasive particles and to provide novel means and method by which an auxiliary support may be soldered or mechanically connected with said heat joined particles of metal.

Another object is to provide an abrading tool formed of a composition of metal for supporting particles of abrasive which may be processed and rendered resistant to wear and yet possess characteristics which will positively retain the particles of abrasive in position thereon until they perform substantially to the full extent of their usefulness with the said supporting metal tending to keep pace with the wear of said abrasive particles so as to cause the cutting edges thereof to remain exposed during the use of the tool.

Another object is to provide an abrading tool formed of a metal composition of the above nature with means by which the said tool may be easily fitted and attached to an auxiliary support.

Another object is to provide a novel method of forming an abrading tool of a metallic composition of the above nature by hardening said tool to a controlled degree of hardness whereby the extent of usefulness of the tool may be greatly increased.

Another object is to provide a novel method of providing an abrading tool of the above nature with a portion thereon which may be soldered or otherwise mechanically connected to an auxiliary support.

Another object is to provide novel means and method of forming an abrading tool of the above character with a main body portion of non-solderable metal and a portion of solderable metal integrally or mechanically bonded with each other.

Another object is to provide improved means and method of forming abrading tools of the above character which will be less expensive and more durable and practical for use.

Other objects and advantages of the invention will become apparent from the following description taken in connection with the accompanying drawings and it will be apparent that many changes may be made in the details of construction, arrangement of parts and steps of the processes or methods shown and described without departing from the spirit of the invention as expressed in the accompanying claims. The invention, therefore, is not intended to be limited to the exact details, arrangements and methods shown and described as the preferred forms only have been given by way of illustration.

Referring to the drawings:

Fig. 1 is a top plan view of a tool embodying the invention;

Fig. 2 is a sectional view taken as on line 2—2 of Fig. 1;

Fig. 3 is a cross-sectional view illustrating a step in the process of manufacture;

Fig. 4 is a view generally similar to Fig. 3 illustrating a further step in the process of manufacture; and

Fig. 5 is a fragmentary side elevation shown partially in section of a compression device used in the process of manufacture.

Several attempts have been made in the past to accomplish the essence of the present invention and some sintered mixtures have been obtained which will function more efficiently than others of the prior art. It has been found, however, that although some marked improvements have been obtained as to greater holding characteristics and resistance to wear the combination of metals used in the present invention have been found to be much more efficient than those previously known in the art; both from the above viewpoint and as to producing a much greater output of work.

One of the many uses of the invention relates to the forming of interchangeable abrading tools for use with machines for abrading lenses. Such tools are adapted to be held by an auxiliary sup-

port by which they are secured to the abrading machine. Such tools are formed of particles of abrasive supported by a sintered mixture of metal functioning as means for supporting the abrasive particles during the abrading operation.

One of the main features of the invention is to provide an abrading tool which will have maximum efficiency and durability to produce the greatest amount of abraded surfaces with a single tool. The tool must be of such a nature as to support the particles of abrasive until they perform the major extent of their usefulness prior to their being dislodged from the supporting means and the supporting means must be of such a nature as to substantially keep pace with the wear of the abrasive particles so as to cause the cutting edges thereof to remain exposed to most efficiently perform their abrading characteristics and means must be provided whereby the tools may be quickly and easily attached to or removed from the auxiliary support. These, and other objects of the invention, particularly that of providing a simple and economical method of forming the tools, are the essence of the present invention.

Referring more particularly to the drawings wherein like characters of reference designate like parts throughout the several views a possible form of tool, as shown in Figs. 1 and 2, comprises a main effective abrading portion 11 formed of a mixture of particles of abrasive such as diamonds, sapphires, corrundum or other suitable abrasive means and particles of metal bonded together by a sintering process.

The main effective abrading portion 11 of the tool has an outer surface 12 of a preformed desired contour shape which will generate the various surface curvatures desired on the lenses or articles to be ground thereby. The main effective abrading portion 12 is of a controlled thickness having an inner surface 13 shaped to engage a contiguous surface of a backing support 14 also formed of sintered metallic particles.

The metallic bond for the effective abrading portion of the tool having the particles of abrasive therein is preferably formed of a mixture of chromium, nickel and copper. The size and amount of the abrasive particles are varied according to the abrading characteristics desired of the tool and according to the shape and size of the tool desired.

It has been found that tools having satisfactory characteristics, depending upon the particular type of abrading desired, may be formed by a metallic bond comprising more than 50% and less than 95% chromium, more than 1 and less than 30% copper and more than a fraction of 1% and less than 40% nickel. Some of the most satisfactory results are obtained from abrading tools or laps whose metallic particles or materials contain more than 55% and less than 80% chromium with the remainder essentially nickel and copper in such a ratio that more than 40% and less than 80% of this remainder is nickel (or, equivalently, that more than 20 and less than 60% of it is copper).

One of the preferred mixtures has been found to be approximately 65% chromium, 20% nickel and 15% copper.

Another satisfactory mixture is approximately 60% chromium, approximately 20% copper and approximately 20% nickel.

The sintering temperature could conceivably vary from as low as 1700° F., which is below the melting point of copper (1950° F. approximately) to above the melting point of nickel (approximately 2650° F.). The time of sintering will depend upon the temperature used, a much longer time being required as the sintering temperature decreases ranging from the order of a few minutes at the higher temperature to possibly as long as several hours for the lower temperatures. It is to be understood, however, that the lowest temperature limit used is such as to be sufficient to bring about a diffusion of the copper with the nickel and chromium of the mix but these processes normally take place so slowly at said low temperatures that such lower temperatures would not be recommended as a desirable procedure. However, it has been found that although sintering below approximately 2200° F. will cause the metallic particles to be bonded together into a coherent mass the resulting alloying is not sufficiently complete to obtain the optimum properties desired by the present invention. Excessive care, however, must be taken if sintering temperatures above approximately 2450° F. are employed because of the tendency of the chromium to react chemically with the atmospheres used during sintering. Some of the most satisfactory results have been secured by sintering in the range of 2250 to 2400° F. for time intervals of the order of 5 to 7 minutes. This latter range, therefore, has been found to be one of the most practical ranges to be employed in accordance with the present invention but the invention is not intended to be strictly limited to this preferred range. The above metallic compositions are substantially non-solderable.

The metallic composition of the portion 14, which constitutes the backing support of the main effective abrading portion of the tool, can be identical with that of the metal bond for said main effective abrading portion or may be of any desirable mix which will retain its shape and become bonded with the effective abrading portion of the tool when given the sintering treatments to compact the main abrading portion of the tool and preferably should also have solderable characteristics under certain circumstances.

In instances when the backing support 14 is to have solderable and workable characteristics a mixture of metallic particles, such as iron and copper particles, are preferably used. A mixture of iron with about 5% copper or iron with about 3% zinc has been satisfactorily used although it should be understood that the percentages are by no means significant. For example, pure iron could be used. The various metallic particles set forth above are of approximately from 200 to 325 mesh.

The proportions of the ingredients used is controlled in part by the sintering temperatures employed in bonding the metallic parts of the main effective abrading portion of the tool and must be controlled so that the metals of the backing support will not melt during the sintering of the bonding metals for said main effective abrading portion. The characteristics desired in the backing portion of the tool will also influence the proportions of metals used in the composition.

In forming the main effective abrading portion of the tool and the backing support 14, as shown in Figs. 3, 4 and 5, a suitable quantity of the uncompacted metal powders used in forming the portion 14 is placed in suitable forming dies as illustrated at 15 in Fig. 3. The forming die, in this particular instance, comprises a casing 16

formed preferably of relatively soft steel. Internally of the casing 16 there is provided a tubular member 17 having a sleeve 18 mounted therein. The sleeve 18 has an upper edge surface 19 shaped to the shape desired of the under surface of the backing support 14. Internally of the sleeve 18 there is supported an arbor-like member 20 which protrudes upwardly a considerable amount above the sleeve 18 and is retained in spaced relation with the tubular member 17 by said sleeve 18. The deposit of metallic particles 15 is placed in said space above the upper surface 19. A hollow plunger 21 having a lower end surface 22 of a shape controlled to produce the interface 13 is mounted on the arbor 20 so as to be free to be pressed downwardly to engage the deposit 15 of the metallic particles. The members 17, 18, 20 and 21 are preferably formed of hardened steel.

The assembly thus formed is then placed within a press, such as shown in Fig. 5, whereby a pressure of a controlled amount may be directed to the plunger 21. The press of Fig. 5 comprises broadly a base plate 23 having uprights 24 thereon on which a second plate 25 is slidably supported. Suitable compression springs 26 normally urge the plate 25 in a direction away from the base plate 23. Suitable stop means, such as nuts 27, limit the upward movement of the plate 25. The assembly set forth above is placed between the plates 23 and 25 with the plunger-like member 21 positioned to be engaged by the plate 25. A plunger 28 slidably mounted in a casing 29 is forced downwardly by hydraulic pressure or the like or through compressed air directed through an inlet 30 into a chamber 31 in said casing 29. It is to be understood that the above press and function thereof is given only by way of illustration. For example, instead of the pressure being exerted from only one direction the pressure may be forced in an upward direction or so as to produce a reciprocal pressure simultaneously or the dies may be arranged to float under the action of pressure. A pressure of from between 20 to 60 tons per square inch has been satisfactorily employed.

It is to be understood that the deposit 15 has been previously levelled off prior to applying said pressure.

The upper surface of the deposit 15 shaped to the end surface 22 is then preferably brushed or otherwise treated to loosen the particles at said surface to bring about a roughening of said surface. The mixture of abrasive particles and metals for the main effective abrading portion of the tool is then deposited in the dies above the mixture 15, as shown in Fig. 4. This deposit is designated as 32 for ease of reference. A plunger die 33 having an end surface 34 of the shape desired of the effective abrading surface 12 of the tool is in this instance employed to produce the shape desired. It is to be understood that a controlled quantity of the mixture 32 is deposited in the dies and that the said deposit 32 is levelled off prior to the compression thereof. The shape of the outer surface of the effective abrading portion of the tool is controlled according to the requirements of the tool and although only one shape and type of tool is illustrated it is to be understood that many different types of tools may be similarly formed. The assembly is then placed in a press such as shown diagrammatically in Fig. 5 and pressure of a desired amount is imparted on the plunger 33. A pressure range of between 50 to 60 tons per square inch has been found to produce desirable results.

Although it has been set forth above that the deposit 15 is first subjected to pressure through the use of a plunger 21, it is to be understood and perhaps preferable that the deposit 15 need not be initially subjected to pressure. In this instance, the loose particles of the deposit 15 would be merely brushed throughout the upper surface thereof to shape said upper surface to approximately the shape desired of the interface 13. In this instance, the deposit 32 of the main effective abrading portion of the tool would be placed in the die above the first deposit and the complete assembly then would be subjected to only one pressure treatment using a suitable die such as diagrammatically illustrated at 33 to control the shape of the 12. In this instance, the pressure employed would be in the neighborhood of 50 to 60 tons per square inch.

Subsequent to the compression of the particles the said compressed particles are removed from the dies and placed in a suitable heating furnace for sintering. The sintering temperatures employed are of the magnitude set forth above.

During the sintering process it is preferable to maintain a non-oxidizing or otherwise inactive atmosphere in order to prevent possible damage to the diamonds and to the bonding metal. The sintering furnaces and the non-oxidizing atmospheres may be of the type set forth in applicant's co-pending application, Serial No. 367,612, filed November 28, 1940.

Upon the completion of the sintering the resultant tool is preferably cooled to room temperature by plunging the said tool into a bath of oil; however, there is no reason why other methods of cooling would not lead to equally acceptable results provided suitable precautions are taken to avoid excessive oxidation or other deleterious action on the tool. In this respect, air cooling, water quenching, molten salt or alloy quenching might be used to advantage. It has generally, however, been found desirable to retain a certain amount of porosity in the final tool because of the cooling effect derived therefrom during use. Although, in most instances, it is desirable that the resultant tool be of a porous nature in some instances the quenching process may be so controlled as to cause the resultant tool to have little or no porosity. The amount of porosity desired in any given tool is determined to a large extent upon the shape, size and general characteristics desired and the use to which the tool is to be put.

The hardness of the tool may be controlled by the temperature employed in the sintering process and to some extent may be affected by the quenching or other cooling treatment.

The tool, including the backing support, during use is preferably attached to an auxiliary support 35, as illustrated in Fig. 2. It is preferable that the backing support possess solderable characteristics whereby the said backing support 14 may be detachably secured to the auxiliary support 35. In order to bring about this result it is quite apparent that the backing support 14 might initially have to be machined and the composition and hardness plus the solderable characteristics of the tool is controlled so that the parts may be properly shaped and assembled with each other. The auxiliary support 35 may be ordinary cold rolled steel or other inexpensive metal. In the construction illustrated the auxiliary support 35 has a reduced portion 36 adapted to extend within the annular backing support 14 and has a surface

37 shaped to engage the lower surface of said backing support. The backing support is preferably attached throughout the contiguous surfaces by soldering or the like. The said auxiliary support is provided with a shank portion 38 having a tapered bore 39 of such shape as to fit the spindle of the conventional type abrading machine.

It is to be understood, however, that in some instances no auxiliary support may be required. It is also to be understood that the tool may be solid in form in which instance if the auxiliary support is used the backing support of the tool will be shaped, fitted and attached to the said auxiliary support in a manner similar to that set forth above.

The bond throughout the interface 13 between the backing support 14 and the main effective abrading portion of the tool may be purely mechanical or result from an alloying of the metals or may be the result of both a mechanical and alloying bond.

In some instances in addition to roughening the surfaces to be joined throughout the interface 13 it might be desirable to dust the surfaces with a copper or other low melting powder. If desired instead of using a backing support 14 formed entirely of sintered metallic particles a solid metallic insert may be used such as set forth in applicant's co-pending application, Serial Number 367,612, filed November 28, 1940. In this instance, the solid backing support could be provided with suitable prongs extending within the material of the portion 14 for a mechanical bond as well as an alloying bond. The solid metallic backing could be substituted wholly or in part for the member 14. It is to be understood that instead of forming the portion 14 of sintered particles of metal the said portion 14 may be a solid metal for example, a solid iron ring of the shape of the portion 14 might be used or of any other desirable shape.

If desired, prior to the compression of the particles, the said particles may be subjected to a wetting through the use of any desirable wetting agent, such as water, glycerine, acetal, alcohol or the like which will facilitate the compacting of the metallic particles under pressure. This greatly increases the holding characteristics of the metal before sintering.

Recommended method of manufacture:

The sintering of properly prepared and proportioned mixtures of chromium, nickel, and copper powders and suitable amounts of industrial diamonds.

Due to the fact that the diamonds, for best results, should be dispersed uniformly throughout the usable portion of the lap powder metallurgy is preferred. In addition this method enables the use of a much lower temperature of treatment than would be otherwise possible.

Experimental evidence available indicates that the melting point of chromium of reasonable purity is in excess of 3000° F. while this would be decreased markedly by the addition of alloying elements considerable deterioration of the diamonds would be anticipated from the use of temperatures greater than 2500° F. due to the chemical action of either the atmosphere or of the chromium rich liquid phase.

At the much lower sintering temperatures any reaction that might occur would proceed at a much slower rate and hence would be less harmful.

Atmosphere control

It is to be anticipated that oxidizing atmospheres of any sort will be harmful because of the known affinity of chromium, nickel, copper, and diamonds (carbon) for this element.

Reducing atmospheres rich in carbon may lead to the formation of a chromium carbide but should have no effect on either the nickel, copper, or diamonds.

Reducing atmospheres rich in hydrogen should not affect any of the metallic components but may exert a deleterious effect on the diamonds.

Partial vacuums should be quite satisfactory except for the points mentioned under oxygen bearing atmospheres.

Successful laps have been made by sintering in an atmosphere composed essentially of carbon monoxide and nitrogen.

Sintering temperatures

Because of possible deterioration of the diamonds, an upper limit of 2500° F. is set on the sintering temperature. Higher temperatures, up to the melting point of chromium, can be used successfully, however, if this can be prevented, neglected, or compensated for by any of several methods which might be used.

The minimum temperature for rapid sintering is probably about 1970° F. the temperature of the copper-chromium eutectic and the lowest temperature at which liquid can exist in the system chromium-nickel-copper. While sintering is quite possible at lower temperatures much longer times will be required than are necessary above 1970° F. The intermetallic diffusion necessary to alloying, homogenization, and compacting proceeds only across a surface of contact. This surface will naturally be of much more limited extent in a solid-solid powder system than in a liquid-solid powder system. In addition the rate of diffusion increases greatly with increasing temperature so the higher temperatures are preferable for reasons of time.

The exact constituents formed during the sintering and, therefore, the exact limits of compositions that can be used satisfactorily will depend upon the sintering temperature.

Sintering time

Since the alloying of the prepared powders will proceed by diffusion and since the rate of diffusion will increase drastically with increasing temperature it is not possible to specify arbitrarily the time at any sintering temperature which will be most suitable.

If the deteriorating effects of the atmosphere on the components of the mixture can be prevented there is no harm in extending the sintering time indefinitely at any given temperature as, in theory, it will require an infinite time to effect complete homogenization of the alloy. However, this does not imply that such complete homogenization is desirable or that it will give the optimum results because both of these points will be affected by the exact composition and sintering temperature selected.

The sintering time must of necessity be increased as the sintering temperature is decreased and vice versa. Practically, however, it is not a simple matter to eliminate all the deteriorating effects of any atmosphere on the components of a given mixture. Hence, a sintering time is usually selected which will give satisfactory and coherent products without undue deterioration. For example, while at 2300° F. seven minutes

sintering in a nitrogen-carbon monoxide atmosphere has been found to give good results, a skin is produced on the surface which must be removed before optimum operating results can be secured. Shorter times will give less "skin" but also poorer compacting, and alloying.

The optimum sintering time, therefore, is determined by the composition of the alloy, the sintering temperature and atmosphere, and the particular properties and structure desired.

General characteristics desired in diamond laps

Diamond laps for glass surfacing should possess three general characteristics:

1. Sufficient mechanical strength to hold the diamonds firmly in place in order that they may do the actual cutting. Contact between the metallic matrix and the glass surface caused by the diamonds pulling out will invariably result in a flowing or "glazing" of the matrix. No accurate evidence exists on the hardness of such a flowed layer but it will undoubtedly obstruct the action of the diamonds even if it does not injure them permanently.

2. Sufficient wear resistance to the combined action of the cooling fluid and the glass chips that the matrix will wear only slightly faster than or substantially keep pace with the wear of the diamonds. Diamonds will cut only as long as proper facets remain on them, and once their edges have been worn off their usefulness is probably lost. Hence, wear on the matrix should neither be so rapid that the diamonds will be torn out before their useful life is ended nor so slow that they will remain embedded after they lose their cutting edges.

3. Sufficient hardness and elasticity, in comparison with the other characteristics, to resist any tendency to flow under the action of the cooling solution used during abrading and the abraded material alone.

The properties required in the matrix, however, will be dependent also on the proportion of diamonds in the mix. The important feature is the rate of wear normal to the lapping surface rather than the rate of volume wear. Thus, if the percentage of diamonds be increased the properties of the matrix can be decreased without serious disadvantage because of the decrease in the exposed surface area. Any possible decrease in the percentage of diamonds is limited by the necessity of preventing the "glazing" resulting from metal to glass contact.

Purpose of the chromium in the mixture

The chromium is the most important component of the metallic matrix because it imparts unique properties to it. The known resistance of chromium to mechanical abrasion may be due either to its general physical properties or, more probably, to the very thin layer of chromium oxide (or of absorbed oxygen) which tends to form on the surface of chromium or its alloys whenever they are exposed to oxidizing conditions. Such a layer would probably also tend to increase the resistance of the alloy to flowing or glazing under the actual use of the tool during abrading.

Under existing methods of production, commercial chromium, even that of the highest purity available, is apt to be extremely hard and/or brittle. This is probably due to the presence of dissolved impurities, either solid or gaseous. This brittleness can be decreased somewhat by alloying other elements with the chromium. However, as long as the resulting alloy consists essentially of chromium or a chromium rich solid solution, i. e. a solid phase in which atoms of the alloying element or elements replace chromium atoms on the body centered cubic chromium space lattice, the other generally valuable characteristics of chromium will be retained.

The alloying elements not only serve to modify the properties of the chromium but also, by their alloying with it, assist markedly in compacting the chromium powder into a coherent mass. The combination and resultant of these two effects determines to some extent the preferred limits of composition given earlier. Should later developments in the production of metallic chromium succeed in eliminating the impurities to such an extent that a tougher and more workable alloy results the amount of one or more of the alloying elements might be reduced appreciably.

Purpose of copper in the mixture

In using the methods of powder metallurgy for this application it is desirable that at least one of the components should be liquid at a reasonable sintering temperature, e. g. a temperature at which the alloying reactions will take place to a sufficient extent in a relatively few minutes in order to minimize damage to the diamonds. In addition this component should possess certain other attributes:

(*a*) A tendency to alloy readily with chromium either alone or in combination with other elements:

(*b*) A resistance to any deteriorating effects of the atmosphere employed:

(*c*) Little or no affinity for the carbon so that it will not tend to attack or dissolve the diamonds.

The metal copper which melts at about 1980° F. and forms an eutectic with chromium (98.5 per cent copper) melting at 1970° F. fulfills these conditions reasonably well and will resist the action of any except oxidizing atmospheres. While it alloys poorly with chromium this tendency can be increased by the addition of a suitable component such as nickel.

Purpose of nickel in the mixture

Nickel has two principal functions in the mixture: First, it assists the copper to alloy with chromium. The chromium rich solid solution of nickel and chromium is able to dissolve more copper as the amount of nickel increases. Second, it strengthens the solidified liquid phase both by dissolving in it and by increasing its ability to dissolve chromium. The solubility of chromium in a nickel-copper liquid solution is greater than it is in pure copper. In addition, the solid formed when either a nickel-copper or a nickel-copper-chromium liquid solidifies will be much stronger and will resist abrasion better than copper alone. Therefore, by proper variations of the components, the abrasion resistance, toughness, hardness and abrasive holding function may be controlled according to the characteristics desired of the tool.

Factors affecting the holding power for diamonds

The grip of the metallic matrix on the diamonds arises from a combination of several factors, among which may be mentioned:

1. *Flow of the liquified portion of the mix around the diamonds.*—This will occur due to the well known tendency of any liquid to wet the

surface of any solid provided a liquid-solid interface is actually established, i. e. the surface is clean. As the liquid metal or alloy solidifies this grip will tend to be increased because of the normal contraction of most metals and alloys on solidification and cooling. By this process the strength of the grip will be determined principally by the mechanical strength and resistance to wear of the solidified liquid. This may be increased appreciably by proper alloying of the liquid, e. g. by producing saturated or supersaturated solid solutions, eutectic or eutectic-like structures, or finely dispersed precipitate in the solidified material. This type of gripping can occur regardless of whether or not the constituent metals alloy completely.

2. *Chemical attack of the liquified portion of the mix on the diamonds.*—This will tend to result in some sort of a transition layer between the liquid metal and the diamond which will probably be intermediate between the two in hardness. However, the essential gripping will still be dependent upon the shrinkage occurring during solidification and cooling, and upon the mechanical strength and resistance to wear of the solidified liquid.

3. *Compacting of the alloy mix.*—Under these conditions the liquid will first flow around the diamond or attack it chemically as above. However, if the composition has been properly adjusted this liquid will then both dissolve the remaining solid and be absorbed by it. This tends to result in alloying of the entire mass together with a concomitant decrease in the percentage of voids which are always present in mixes of powdered metals. Under these conditions, while the grip is still determined by the shrinkage of the matrix during reaction (and solidification) the mechanical strength and resistance to abrasion of such a matrix will be much greater because it will possess the general characteristics of the high melting point metal, such as chromium, rather than those of the lower melting or alloy.

Factors affecting the homogeneity of the matrix

The alloying, while it should be as nearly complete as possible, need not necessarily result in a completely homogeneous structure of the matrix. Unless either excessively high sintering temperatures or excessively long sintering times are used, either of which may lead to damage to the diamonds, the high melting metal will usually give evidence of incomplete diffusion. This means that while the central part of a given region will be essentially unchanged chromium, for example, successive portions of the region outside of this will contain increasing amount of the alloying metals. The existence of such zones of incomplete diffusion are not harmful and may even be beneficial.

In addition it should be pointed out that while thorough if not complete alloying of the mix is desirable and while a major constituent of the alloyed mix should be, for the case of chromium, a chromium-rich solid solution either completely or partially homogeneous, it is not necessary that the alloying constituents remain either entirely or partially in solid solution after cooling. Indeed proper precipitation of the alloying elements might well result in appreciable improvement of the matrix properties and/or the properties of the lap.

The invention herein disclosed is intended to cover all different types of tools with different degrees of hardness and wear resistance according to the pressure and temperature controls used in fabricating the tool and of the particular compositions of metal used for said tools, in accordance with the teachings of the present invention.

From the foregoing description it will be seen that simple, efficient and economical means and methods have been provided for accomplishing all of the objects and advantages of the invention.

Having described my invention, I claim:

1. A metal composition for use in forming a sintered metallic bond for abrasive particles consisting of a mixture of from more than 50% and less than 95% chromium, more than 1% and less than 30% copper and more than a fraction of 1% and less than 40% nickel, with the percentages of copper and nickel being decreased only when the percentage of chromium is increased and with the percentages of the copper and nickel being varied with respect to each other according to the combined balance of said metals required.

2. A metallic composition consisting of from 50% to 95% chromium, 1% to 30% copper and from a fraction of 1% to 40% nickel, with the percentages of copper and nickel being decreased only when the percentage of chromium is increased and with the percentages of the copper and nickel being varied with respect to each other according to the combined balance of said metals required.

3. A metallic composition comprising more than 55% and less than 80% chromium with the remainder essentially nickel and copper in such a ratio that more than 40% and less than 80% of the remainder is nickel.

4. A metallic composition comprising more than 55% and less than 80% chromium with the remainder essentially nickel and copper in such a ratio that more than 20% and less than 65% of the remainder is copper.

5. A metallic composition comprising approximately 65% chromium, 20% nickel and 15% copper.

6. A metallic composition comprising approximately 60% chromium, approximately 20% copper and approximately 20% nickel.

7. An abrading tool comprising abrasive particles substantially uniformly dispersed throughout a sintered mixture of approximately 65% chromium, 15% copper and 20% nickel and having a backing support of solderable metal thereon.

8. A metallic composition for use in forming a sintered metallic bond for abrasive particles comprising a mixture of more than 55% and less than 80% chromium with the remainder essentially nickel and copper in such a ratio that more than 40% and less than 80% of this remainder is nickel.

9. A metallic composition for use in forming a sintered metallic bond for abrasive particles comprising a mixture of more than 55% and less than 80% chromium with the remainder essentially nickel and copper in such a ratio that more than 20% and less than 65% of the remainder is copper.

10. A metallic composition for use in forming a sintered metallic bond for abrasive particles comprising an alloy of approximately 65% chromium, 20% nickel and 15% copper.

11. A metallic composition for use in forming a sintered metallic bond for abrasive particles

comprising an alloy of approximately 60% chromium, approximately 20% copper and approximately 20% nickel.

12. An abrading tool comprising abrasive particles held in a sintered metallic bond consisting of more than 50% and less than 80% chromium with the remainder essentially nickel and copper in such a ratio that more than 40% and less than 80% of this remained is nickel.

13. An abrading tool comprising abrasive particles held in a sintered metallic bond consisting of more than 50% and less than 80% chromium with the remainder essentially nickel and copper in such a ratio that more than 20% and less than 65% of this remainder is copper.

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