I/We ILLINOIS TOOL WORKS INC.

of (a) 8501 West Higgins Road
Chicago, Illinois 60631
United States of America

hereby apply for the grant of a (c) Standard/Full Patent for an invention entitled

(S) Shankless Coupling for Tools and Tool Holders and Method
for Quick Change for Cutting Tools

which is described in the accompanying (g) complete specification.

(Note: The following applies only to Convention applications)

Details of basic application(s)

<table>
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<tr>
<th>Application No.</th>
<th>Country</th>
<th>Filing Date</th>
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<td>420,760</td>
<td>United States of America</td>
<td>September 21, 1982</td>
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Address for Service: PHILLIPS ORMONDE AND FITZPATRICK
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Dated (d) September 6, 1983
ILLINOIS TOOL WORKS INC.

[Signature]
Thomas Warren Buckman
Vice President
I9272/83

DECLARATION FOR A PATENT APPLICATION

In support of the (b) Convention application made by

ILLINOIS TOOL WORKS INC.

(hereinafter called “applicant(s) for a patent”) for an
invention entitled (c) Shankless Coupling for Tools and Tool Holders
and Method for Quick Change for Cutting Tools

(c) THOMAS WARREN BUCKMAN, of
Illinois Tool Works Inc.
8501 West Higgins Road, Chicago, Illinois 60631
United States of America

I do solemnly and sincerely declare as follows:

1. I am authorized to make this declaration on behalf of the applicant(s).

2. I am the actual inventor(s) of the invention.

3. The basic application(s) for patent or similar protection on which the application is based
is/are identified by country, filing date, and basic applicant(s) as follows:

   (a) in the United States of America, on September 21, 1982,
   by Stephen Sanaghan Duncan and Walter Goss Huber

4. The basic application(s) referred to in paragraph 3 hereof was/were the first application(s)
made in a Convention country in respect of the invention the subject of the application.

Declared at (a) Chicago, Illinois, U.S.A.
Dated (d) September 6, 1983

ILLINOIS TOOL WORKS INC

Thomas Warren Buckman
Vice President
In combination a machine tool and a cutting tool for use with said machine tool, quick change coupling means for attaching said cutting tool to a support means on said machine tool, said coupling means having a first portion associated with said cutting tool and a second portion associated with said support means, said first and second portions including generally radially disposed means adapted to directly and cooperatively intermesh in a disengageable manner for self-centering of said cutting tool relative to said support means.

A toolholder for use with a machine tool including a tool holder body having first means for receiving a portion of said tool therein, second means for receiving a second portion of said tool within said first means, third means disposed axially relative to said tool holder body for engagement by a securing means associated with a support means on said machine tool for drawing said tool holder axially towards said support means.
means, fourth means concentrically disposed relative to said third means for engagement by a concentrically disposed complimentary means associated with said support means, said fourth means including generally radially extending means enabling self-centering coupling of said tool holder to said complimentary means whereby an axial drawing force created by said third means causes said fourth means to engage and self-center the tool holder relative to the complimentary means on said support means.

41. A method of changing tool holders used with a machine tool comprising the steps of engaging the tool holder to be replaced by a movable means, releasing said tool holder from the spindle, moving the toolholder to be replaced from its in use position proximate the spindle, bringing a replacement tool holder proximate the spindle, positioning said replacement tool holder to permit engagement of a means for drawing said tool holder towards said spindle, engaging a means for drawing said tool holder towards said spindle, drawing said tool holder towards said spindle to thereby establish a rigid drive for said tool holder having substantially zero backlash via said cooperating radially extending teeth, centering of said tool holder by cooperating radially disposed teeth responsive to said means for drawing said tool holder towards said spindle.
COMPLETE SPECIFICATION

(ORIGINAL)

Application Number: 19272/83

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Int. Class

Complete Specification Lodged:

Accepted:

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APPLICANT'S REP.: CASE 4093

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STEPHEN SULLAGH DUNCAN
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Address for Service is:

Complete or restriction for the invention entitled:

"SHANKLESS COUPLING FOR TOOLS AND TOOL HOLDERS AND METHOD FOR QUICK CHANGE FOR CUTTING TOOLS"

This written statement is a full description of this invention, including the best method of performing it known to the applicant.
SHANKLESS COUPLING FOR TOOLS AND TOOL HOLDERS AND METHOD FOR QUICK CHANGE FOR CUTTING TOOLS

Background of the Invention

1 This invention relates generally to an improved method and apparatus for accomplishing quick change of cutting tools used with a machine tool, and more particularly to a shankless coupling.

Standard and special metal cutting machine tools, in operation today, utilize power driven spindles and tool supports which are designed to accommodate a shank-type tool or tool holder. Shank-type, in this instance, refers to any of the commonly known shank-type devices, e.g., V-flange, Morris taper, straight shank, etc.

Tools and tool holders utilizing a shank, e.g., a V-flange holder, have the obvious disadvantage of being bulky as well as creating problems of interchangeability of tools between machine tools which have been adapted for the particular size of shank of the shank-type tool holder. An example of this is where the power driven spindle of one machine tool has been adapted to accommodate a shank-type tool holder of a particular size while the machine tools positioned around this machine have been adapted to accommodate tool holders of other configurations or sizes. Here it is evident that each machine tool in this situation would, of necessity, have its own supply of tools or tool holders that are of the particular configuration and size that each of the machines has been adapted to accommodate. Accordingly, a numerically controlled machine tool with a storage caddy of tools and holders, usually ranging from 30 to 50 tools or tools with their tool holders...
which has a robot associated therewith for accommodating changing of the cutting tools, will be precluded from sharing those tools with other machines which have been adapted to accommodate tools or tool holders with different shank sizes or configurations.

Thus, it is seen that when a machine which accommodates shanks of a particular size is juxtaposed a machine which accommodates shanks of a different size it is readily apparent that they must have their own separate supply of tools and tool holders.

Another distinct problem with machine tools having a power driven spindle which is designed to accommodate a shank-type tool holder is that the design of the spindle is compromised in order to be able to provide clearance for the shank. An example of such a compromise is seen in the oversizing of the bearing at the end of the spindle which is made large enough to support the spindle and yet permit the shank to pass therethrough. Thus any of the inherent problems of an oversized bearing will be found in a spindle of this type. A significant problem attributable to a very large bearing used with a power driven spindle is that the maximum speed at which the spindle can be driven for long periods of time using a predetermined amount of horsepower is significantly less than a spindle which employs a smaller bearing using the same predetermined amount of horsepower.

A common problem which has been attempted to be overcome in many ways by machine tool operators and manufacturers, is the inherent problem of a shank seizing within the bore in which it is fitted. Normally some type of a blow or extreme amount of pressure is required to free a shank from within an accommodating bore. A tool or tool holder subjected to repeated seizing within an
accommodating bore and the stresses created by the various methods of extraction often show excessive wear or damage.

Yet another problem with a shank-type tool holder is that when the cutting tool is to be adjusted relative to the holder a particular fixture is needed for supporting the tool holder in a manner such that a precise measurement of the extension of the cutting tool therefrom can be made. Because of the need for a special fixture it is not unknown for the operator of the machine tool to attempt to make an adjustment by simply standing the shank-type tool holder on its smaller end and attempting the adjustment by measuring up from the surface its resting on. In so doing the tool holder may be knocked over resulting in chipping of the cutting tool. Clearly this is an extreme economic waste when considering the substantial expense of cutting tools used in the machining operations of the type considered here.
Summary and Objects of the Invention

Generally, machine tools are used for precision machining operations and, as is the tendency in the industry, are becoming more frequently computer controlled. The potential for high speed machining as well as high speed interchange of tools is a very important objective. To enable a plurality of machine tools or machine tool turrets each with a multiplicity of cutting tools mounted thereon to have high speed interchangeability and to enable these same machine tools to utilize a common supply of cutting tools having standardized couplings will provide substantial savings in time and money.

Accordingly it is the general object of this invention to provide a quick change coupling which substantially avoids the problems of the prior art.

A related object is to provide a quick change coupling which is relatively simple and inexpensive both in manufacture and use, and yet is highly reliable over a long service life of multiple reuses.

Another object is to provide a tool and tool holder which may be readily engageable and disengageable from a support without the necessity of external forces being applied thereto.

It is another object of the invention to provide a tool or tool holder which will accommodate mechanical means for drawing it proximate the tool support, has the capability of self-centering when drawn proximate the support, will enable transmission of a
positive driving force through the coupling when used with a power driven spindle, has a provision for accommodating debris which may have accumulated in the coupling, and will accommodate torque applied in either direction.

Another specific object is to provide a quick change coupling and a method of utilizing the coupling to standardize machine tools and thereby enable a plurality of machine tools to be supplied with cutting tools from a common storage facility wherein each of the cutting tools stored therein includes a universal coupling portion.

A further object is to provide a coupling wherein each of the coupling portions is of a standardized configuration and wherein the radially extent of a coupling portion is insignificant as long as there are portions of the coupling which mate.

Another object of this invention is to provide a tool or tool holder which includes means for accommodating the robotics of a quick change system such that the tool or tool holder can be readily moved back and forth between a storage facility and the tool support.

Important objects of the instant invention include providing a tool or tool holder which may be repeatedly coupled and uncoupled from a tool support without affecting the accuracy and efficacy of the coupling; insuring that the accuracy of the alignment of the tool or tool holder be maintained during its multiple reuses; and minimizing run out and precession of the cutting tool relative to a spindle when the coupling is used with a rotating spindle.

Briefly, and in accordance with the foregoing objects, the invention provides a novel quick change coupling and method of use thereof.
1. In accordance with one aspect of the invention, a quick change coupling is disclosed which comprises a pair of complimentary intermeshing portions which interface in a self centering manner which have substantially zero backlash when torque is applied thereto. In a preferred form the intermeshing portions each have generally radially extending teeth.

Another aspect of the invention includes the removal and replacement of a cutting tool on a support in the quickest possible manner and the elimination of multiplicities of separate tool caddies for discrete machines.

Brief Description of the Drawings

The present invention will best be understood from the following specification when taken in consideration with the accompanying drawings wherein:

Fig. 1 is a partial sectional view of a portion of a prior art machine tool spindle and tool holder;

Fig. 2 is a partial sectional view of a portion of a machine tool spindle and a tool holder incorporating the coupling of the instant invention;

Fig. 3 is a view taken in the direction of arrows 3-3 in Fig. 2 showing a portion of one embodiment of the coupling associated with the spindle;

Fig. 4 is a partial sectional view taken in the direction of arrows 4-4 in Fig. 2 showing one embodiment of the portion of the coupling associated with the tool holder;

Fig. 5 is a side view of a cutting tool incorporating the principals of the instant invention; and

Fig. 6 is a partial view in cross-section showing the intermeshing teeth of the drive coupling of the instant invention.

The claims defining the invention are as follows:-

1. In combination a machine tool and a cutting tool for use with said machine tool, quick change coupling means for attaching said cutting tool to a support means on said machine tool, said coupling means including a plurality of teeth on each of said tool and said support means, said teeth being interlocking with each other in a manner so that they mesh and unmesh and thereby effect the changing of the cutting tool to a second cutting tool without the necessity of engaging the tool by hand, and said coupling means including an arbor provided on said tool for engaging a corresponding hole in the support means on said machine tool as a means of locating said tool in the spindle of said machine tool.
Detailed Description of the Preferred Embodiments

1. The coupling disclosed herein is shown for purposes of illustration as being associated with a power driven spindle. However, it should be noted that it is known in the art to mount tools and tool holders on power driven rams where the tool or tool holder is non-rotatable. It is also known to mount tools and tool holders on multi-sided turrets wherein a single tool is presented to a rotating workpiece for work thereon.

Referring now to the drawings and initially to Fig. 1 there is shown a common shank-type tool holder 12, in the industry referred to as a V-flange holder and a power driven spindle 14 of a machine tool 16 which has been adapted to accommodate the shank-type tool holder 12. This is one of the preferred type tool holders in the industry and includes a flange 18 having a substantially V-shaped groove 20 therein for engagement by the robotics associated with the machine tool 16. The robotics are particularly adapted for extracting the tool holder 12 from the end of the power driven spindle 14 and moving the tool holder 12 back and forth between a storage position (not shown) to the end of the spindle. As seen in Fig. 1 the prior art tool holder 12 includes an end 22 for accommodating a tool (not shown) and an end 24 including a tapered shank 26. In the distal end of the tapered shank 26 there is shown a threaded bore 28 which is engageable by the draw bar 30 of the machine tool 16 for drawing and retaining the tool holder 12 axially relative to the end of the spindle 14. The transmission of the torque from the power driven spindle 14 to the tool holder
12 is accomplished through a pair of keys (not shown) which mechanically engage the flange 20 of the tool holder 12 with the spindle 14. This type of engagement, i.e., keys and slots (not shown), which is the common type of interconnecting for this type of tool holder, permits substantial amounts of back-lash of the tool holder 12 relative to the spindle 14. When a tool holder of the type shown in Fig. 1 is to be utilized with a machine tool it is necessary for the spindle 14 to be modified to include frustoconical bore 32 which is of a particular dimension to closely accommodate the particular dimension of the taper 26 of the shank-type tool holder 12.

Due to the fact that the end of the power driven spindle 14 is adapted to accommodate the shank 24 of a shank-type tool holder 12, it should be noted, that the size of the bearing 34 and its positioning is compromised in that the bearing 34 must be of a diameter to permit the shank 24 of the tool holder 12 to pass therethrough. As will be discussed later, there are advantages to controlling the size and position of the bearing.

Referring now to Fig. 2, there is depicted a tool holder 40 shown attached to a power driven spindle 42 of a machine tool 44 through a coupling 46 embodying concepts of the instant invention. The tool holder 40 with end 48, which is shown for illustrative purposes only with the knowledge that any of the known type tool attaching mechanisms could be used in its stead, has a longitudinal axis 50 at one end of which there is a bore 52 for accommodating the shank of a cutting tool (not shown) and at the other end of which there is a radially disposed first portion 54 of the coupling 46. The bore 52 includes locking screws (not shown) for securing the shank of a cutting tool.
tool (not shown) relative thereto. Extending coaxially with the longitudinal axis 50 of the tool holder 40 is a threaded bore 54 for receiving the threaded end 56 of the draw bar 58 of the machine tool 44, the necessity of which will be explained hereinafter. It should also be noted that the particular draw bar 58 and the means for attaching it to the tool holder 40, e.g., the threaded bore, is also shown for illustrative purposes only and it should be understood that any of the common attaching devices used for securing a draw bar to a tool or tool holder may be incorporated herein. Included in the tool holder 40 is a common flange 60 having a V-shaped groove 62 therein enabling engagement thereof by the robotics associated with the machine tool 44 for affecting movement of the tool holder 40 to and from a storage area (not shown) and the end of the spindle 42. As seen in Fig. 2, the bearing 64 is substantially smaller in its overall diameter when compared to the bearing 34 of the prior art device 12. The intention is to show how significantly the sizes of the bearings 34 and 64 may vary when there is a predetermined amount of horse power and an identical cutting tool (not shown) used as constants. Thus, it will be appreciated that no special provisions within the spindle 40 are necessary other than for accommodating the draw bar 58. It should be noted that it is contemplated herein that a common bayonet-type mount as well as other mechanical mechanisms may be employed herein for securing the tool holder proximate the end of the spindle thereby eliminating the need for a draw bar. In this latter instance the bearing 64 may be even smaller. As is known in the arts, a smaller bearing may be run at higher speeds than a larger bearing towards said support means, third means concentrically disposed
of the same material with less heat build-up, etc.

Referring now to Figs. 3 and 4, the two complimentary portions 66, 68 of the coupling 46 of the instant invention are shown therein. While it should be understood that a particular tooth form is disclosed and discussed herein, there are other tooth forms which will accomplish the objectives of the instant invention. As seen in Fig. 3, the portion 66 of the coupling 46 associated with the face of the spindle 42 includes curved teeth 70 extending from the outer periphery inwardly. The teeth 70 are spaced equidistantly or in a pattern completely around (not shown) the circumference of the coupling portion 66. Each of the curved teeth 70 has two lateral faces, a concave or inward face 72 and a convex or outward face 74. For this particular tooth configuration there is a contact point \( P_1 \) on either of the faces, there is an associated spiral angle \( A_1 \) and an associated pressure angle \( B_1 \) (see Fig. 6). Referring to Fig. 4, it is seen therein that the generated tooth pattern is a mirror image of the tooth pattern as depicted in Fig. 3. Each tooth 76 of coupling portion 68 has a contact point \( P_2 \) along each concave face 78 or convex face 80 thereof, and a spiral angle \( A_2 \) and a pressure angle \( B_2 \) (see Fig. 6) that is equal to the angles \( A_1 \) and \( B_1 \) for the associated contact point \( P_1 \) of each tooth 70 of the coupling portion 66 depicted in Fig. 3. It should be noted at this point that while other tooth configurations are contemplated herein it is also contemplated that the generated pattern of teeth need not be continuous in its extent around the faces of the coupling portions. Again it should be noted that references made to teeth are with the understanding that any radially disposed means which will accomplish the objectives of the instant invention are intended to be contemplated hereby.

22. A cutting tool as set forth in claim 21 wherein each of said teeth of each plurality includes an inner concave and an outer convex tooth face being so configured that any contact
Referring again to Figs. 3 and 4, it will be seen that there are generally radially disposed teeth 70 and 76 which constantly increase in dimension as they radiate outwardly. Accordingly, a coupling portion (not shown) of a particular diameter may accommodate a second coupling portion (not shown) of a different diameter as long as they include tooth means which will engage at a diameter common to both portions. Thus a spindle having a first portion associated therewith which is of a first diameter, may accommodate tools or tool holders to be driven thereby, which are of a different diameter. Ideally, the diameter of a coupling portion associated with the spindle is larger than the diameter of the coupling portion associated with the cutting tool. While it may be considered to be not necessarily advantageous to have a cutting tool driven by a coupling portion associated therewith which has a diameter substantially larger than the diameter of the coupling portion associated with the spindle. It should be understood that the torque being transmitted can be controlled by the speed of the spindle and the amount of engagement of the cutting tool with a substrate.

Referring to Fig. 6, there is depicted the intermeshing of the teeth 70 and 76 of two coupling portions 66 and 68 and a showing of a clearance area 82 in the root of each tooth 70 and 76 to accommodate debris which may have accumulated on the face of the teeth. Bits of debris which may inhibit full engagement of the teeth 70 and 76 can thusly be wiped into the clearance area 82 by the teeth as they are intermeshed. It should be understood that the clearance area 82 is not critical to the concept of the coupling or uncoupling and may be omitted in certain applications. The inclusion of an open clearance area 82 as depicted in Fig. 6 would not necessarily be desirable when a coolant flow problem would arise because of intercommunication of the clearance areas 82 with
porting (not shown) within the spindle and tool or tool holder for the coolant flow.

As seen in Fig. 5, there is shown a cutting tool 84 having one portion 68 of the coupling 46 formed as an integral part thereof. Included as an integral part of the cutting tool are those features necessary to facilitate engagement by the robotics (not shown) associated with the machine tool for movement of the cutting tool 84 to and from a storage facility (not shown) and the spindle 42 of the machine tool 44. As indicated by the distance D, it should be readily apparent that the overall length dimension of this unitary device 84 may be substantially less than that of a tool holder and cutting tool combination which of necessity includes the structure for attachment of the cutting tool to a holder. Accordingly, by eliminating the bore portion of a holder and the structure attendant thereto and the portion of a cutting tool necessary to cooperate with the bore portion (not shown), the overall length dimension D of the integrally formed cutting tool may be substantially decreased. The apparent advantage of such a configuration is that a greater degree of flexibility in the size of articles being machined is increased when the area in which the cutting tool is being used is restricted. When reference is made herein to cutting tools it is to be understood that any of the common types of cutting tools is intended to be included, e.g., insertable blade type cutters, carbide tip cutters, etc.

As an alternative, the coupling portions 66 and 68, depicted in Fig. 3 and 4, may be formed integrally as part of the end of the power driven spindle 42 or tool support (not shown) and the
tool 84 or tool holder 40, respectively. Also, it should be understood that each of the portions 66 and 68 of the coupling may be separately formed and subsequently attached to the spindle 42 or tool support (not shown) and tool 84 or tool holder 40, respectively. When forming the coupling portions 66 and 68 as separate pieces it is then incumbent that each of the portions be attached so as to be centered relative to the rotational axis of the spindle 42 or tool support (not shown) and the tool 84 or tool holder 40, respectively. As will be appreciated by those skilled in the art, the attachment of a separate pieces may be accomplished by any suitable means (not shown), e.g., bolts, welding, etc. Accordingly, it should be readily apparent that by forming the coupling portions as separate pieces an adaptor has been formulated.

While a ring of substantially radially disposed teeth has been shown on each of the coupling portions 66 and 68, it is contemplated that there may be a plurality of bands (not shown) of teeth on each portion of the coupling. Each of these bands may be disposed radially relative to the other bands. When bands of teeth of a generally arcuate configuration are utilized, each band may be formed so as to have the teeth therein curved in a predetermined direction. By including bands of teeth which extend in different predetermined directions at different radial distances, it can be seen that tool holders of different diameters may be selectively designed to engage, in a selective manner, a particular band. In the alternative, engagement of a particular tool or tool holder may be precluded due to an inability of the coupling portion thereon to engage with the coupling portion on the support or spindle. Thus, selectivity as to which cutting tools may be
accommodated by a particular spindle may be controlled. In a situation were right hand and left hand cutting tools are employed it is obviously undesirable for an incorrect cutting tool to be engaged due to the fact that when a cutter is run backward high stresses and friction are encountered and the cutter may be destroyed.

A distinct advantage to using a tool 84 or tool holder 40 of the type disclosed herein, is that the user may advantageously accomplish measurement of the axial extension of the cutting tool by simply setting the tool 84 or tool holder 40 on a planar surface with the teeth 76 of the coupling portion resting there against and measuring from the planar surface to that point of the cutting tool furthest from the support surface.

The coupling as disclosed as part of this invention has as one of its principal advantages the standardization of machine tools which have been particularly adapted to accommodate shank-type tool holders. Commonly, machine tools which have been adapted for shank-type tools and tool holders are no longer universal due to their being adapted to receive a particular size of shank. A secondary advantage when using the coupling of the instant invention is that the machine tool and/or robotics which service the machine tool need no longer have the capability of applying the substantial amount of force necessary, either by hammering or otherwise, to uncouple a seized shank-type tool or tool holder.

When standardization of variously adapted machine tools is desired the modification of the end of the power driven
spindle or support may be accomplished by either the machining, of the complimentary coupling portion therein or the attach-ment of an adaptor having the complimentary tooth portion as part thereof. Thus, a common tool caddy having a multiplicity of tools or tool holders may be established which, in the case of numerically controlled robotically fed machine tools, will eliminate the need for separate tool caddies having tools or tool holders which are particularly adapted for each machine.

As is understood by those familiar with machine tools, the maximum speed with which a machine tool operates is limited by the maximum speed at which the bearing within the spindle may operate. Clearly, a machine tool which is numerically controlled and capable of operating for many hours and sometimes days at a time without operator assistance, can potentially have a heat build-up within the bearing if the spindle were to be driven at too high a speed. Knowing that the bearing is the limiting factor in the speed with which a machine tool can operate, it is then understood that a particular machine tool which is adapted to accommodate a large shank-type tool holder will have a much slower maximum speed than a machine tool which has been adapted for a shank-type tool holder which is much smaller. Accordingly, when a cutting tool which may be operated at high speed is used with a machine tool adapted to accommodate large size shanks, it is understood that the cutter cannot be operated at a greater speed than the maximum permitted by the machine tool. Clearly an inefficient situation arises which may be overcome by the incorporation in the machine tool of the concepts of this invention. By permitting the use of a smaller bearing thereby enabling higher rotational speeds of the spindle, it will be
seen that the machine tool has greater versatility in using cutters which are designed to operate at high RPM.

To accomplish the changing of a tool or tool holder, of the type disclosed herein, the robotics associated with the machine tool may engage the means provided on the tool or tool holder and grip the same. Thus, to change a cutting tool on a moving spindle or support, the machine tool is typically slowed or stopped permitting the robotics to grip and move the tool or tool holder as the draw bar releases. Once the draw bar is released, movement is then permitted of the tool or tool holder to its position in the storage facility. Thereafter, the robotics may position the next cutting tool to be used proximate the end of the spindle wherein the draw bar will engage and securely fix the tool or tool holder relative thereto. It should be noted that as the draw bar draws the tool or tool holder towards the end of the spindle, the teeth of the two portions of the coupling will intermesh and will self center the tool or tool holder thereby bringing the rotational axis of the cutting tool into line with the rotational axis of the spindle. Thus, it can be seen that a single tool caddy with robotics can control movement of cutting tools to and from the tool and can supply a multiplicity of machine tools because of the interchangeability facilitated by the unique universal coupling of this invention.

In use, a machine tool having a spindle or support with a coupling of this invention associated therewith can engage and support, and in the case of the spindle, drivingly engage, a tool holder or cutting tool having a complimentary portion of the coupling thereon. To accomplish the engagement of the
to accommodate mechanical means for drawing it proximate the tool support, has the capability of self-centering when drawn proximate the support, will enable transmission of a tool or tool holder, the coupling portions are juxtaposed with the teeth intermeshed and a draw bar, or other means, is engaged in such a manner as to positively intermesh the teeth of the coupling portions. The principal advantage of the instant invention is accomplished when the coupling portions are secured together. Coupling very precisely locates the rotational axis of the tool relative to the rotational axis of the spindle or support and due to the increased surface area found in the curvature of the teeth there is a better load distribution and a high torque load capacity. It should be understood that the coupling portions can be used as a self clutching coupling by utilizing a spring or the like having a predetermined biasing force such that the coupling portions will disengage under a predetermined torque loading. The inherent ease of the uncoupling of a tool or tool holder from a spindle or support should be readily apparent in that when the means for holding the two coupling portions together is released the coupling will essentially fall apart.

While a particular tooth configuration has been disclosed and it should be noted that the tooth configuration was disclosed in patent no. 4,307,797 which is commonly owned along with this application by Illinois Tool Works Inc., and for purposes of this disclosure the teeth are referred to as generally radially extending and generally radially disposed, other forms such as directly radially extending teeth as well as radially disposed means providing a positive engagement and self-centering are intended to be contemplated herein.

The specific example of the present invention as shown and described herein is for illustrative purposes only.
invention provides a novel quick change coupling and method of use thereof.

1. Various changes in structure will no doubt occur to those skilled in the art, and will be understood as forming a part of the invention in so far as they fall within the spirit and scope of the appended claims.
The claims defining the invention are as follows:

1. In combination a machine tool and a cutting tool for use with said machine tool, quick change coupling means for attaching said cutting tool to a support means on said machine tool, said coupling means having a first portion associated with said cutting tool and a second portion associated with said support means, said first and second portions including generally radially disposed means adapted to directly and cooperatively intermesh in a disengageable manner for self-centering of said cutting tool relative to said support means.

2. A combination as set forth in claim 1 wherein said first portion is integral with said cutting tool.

3. A combination as set forth in claims 1 or 2 wherein said second portion is integral with said support means.

4. A combination as set forth in claim 1 wherein said generally radially disposed means includes a plurality of generally radially extending teeth.

5. A combination as set forth in claim 1 wherein said support means is a power driven spindle.

6. A combination as set forth in claim 5 including securing means for drawing said first portion axially into engagement with said second portion on said spindle to thereby substantially simultaneously self-center said cutting tool relative to said spindle and to establish a rigid drive for said cutting tool through said coupling means while limiting backlash within the coupling means to substantially zero.
threaded bore 28 which is engageable by the draw bar 30 of the
driven spindle 14 to the tool holder.

7. A combination as set forth in claim 1 including a tool
holder adapted to releasably support said cutting tool, said
first portion integral with said tool holder.

8. A combination as set forth in claim 1 or 7 wherein said
generally radially disposed means on first portion and said
second portion each includes a plurality of curved teeth, each
of the teeth of each plurality having an inner concave and an
outer convex tooth face wherein each tooth being so configured that
any contact point along both the inner and the outer face
has a spiral angle and pressure angle which is equal to that of
its corresponding contact point along the respective outer convex
and inner concave faces of the outer portion.

9. A combination as set forth in claim 9 wherein the width
of each curved tooth varies from the innermost tooth portion to
the outermost tooth portion.

10. A combination as set forth in claim 9 wherein said tool
holder includes means to permit adjustment of the cutting tool
supported thereby relative thereto to adjust the distance of the
outermost portion of the tool from the spindle, whereby precise
adjustment may be accomplished by resting the tool holder with
the first portion against a flat surface and measuring therefrom
to the outermost portion of the tool.

11. A combination as set forth in claim 8 wherein a root
is formed between adjacent pairs of teeth of each of said
pluralsities of teeth, each root being dimensioned to receive
debris.
12. A combination as set forth in claim 1 wherein said support means is a power driven spindle supported by a bearing, said bearing having an inner diameter sufficient to permit passage of a securing means.

13. A combination as set forth in claim 1 wherein said coupling means forms an adapter assembly, means for attaching said first portion of said coupling means relative to said cutting tool and means for attaching said second portion of said coupling means to said support means whereby a machine tool designed to accommodate cutting tools and tool holders of a particular configuration may be modified to be universal by said coupling means.

14. A combination as set forth in claim 1 wherein the maximum extent of said generally radially disposed means associated with said first portion is equal to or less than the maximum extent of said generally radially disposed means associated with said second portion.

15. A combination as set forth in claim 1 including means associated with said cutting tool for permitting engagement by a handling means for moving said cutting tool proximate to and away from said support means.

16. A cutting tool for use with a support means including a tool body having first means for performing cutting-type work on a workpiece formed therein, second means positioned axially relative to said first means for engagement by a securing means associated with said support means for drawing said tool axially
towards said support means, third means concentrically disposed relative to said second means for engagement by a concentrically disposed complimentary means associated with said support means said third means including generally radially disposed means enabling self-centering coupling of said tool to said complimentary means, whereby an axial drawing force created by said second means causes said third means to engage and self-center the tool relative to the complimentary means on said support means.

17. A cutting tool as set forth in claim 16 including attaching means for fixedly securing said third means to said tool body.

18. A cutting tool as set forth in claim 16 wherein said third means is disposed proximate a plane substantially perpendicular to the longitudinal axis of said tool body.

19. A cutting tool as set forth in claim 16 wherein said second means includes a threaded bore extending coaxial with the longitudinal axis of said tool body.

20. A cutting tool as set forth in claim 16 wherein said body includes a threaded bore and said securing means is a draw bar adapted to extend axially relative to the support means to engage said thread bore and thereby draw said tool toward said support means.

21. A cutting tool as set forth in claims 16 or 19 wherein said third means and said complimentary means each include a plurality of curved teeth.
22. A cutting tool as set forth in claim 21 wherein each of said teeth of each plurality includes an inner concave and an outer convex tooth face being so configured that any contact point along both the inner and the outer faces has a spiral angle and pressure angle which is equal to that of its corresponding contact point along the respective outer and inner faces of the other of said third means and said complimentary means.

23. A cutting tool as set forth in claim 16 wherein said support means is a power driven spindle.

24. A toolholder for use with a machine tool including a tool holder body having first means for receiving a portion of a tool therein, second means for releasably securing said portion of said tool within said first means, third means disposed axially relative to said tool holder body for engagement by a securing means associated with a support means on said machine tool for drawing said tool holder axially towards said support means, fourth means concentrically disposed relative to said third means for engagement by a concentrically disposed complimentary means associated with said support means, said fourth means including generally radially extending means enabling self-centering coupling of said tool holder to said complimentary means whereby an axial drawing force created by said third means causes said fourth means to engage and self-center the tool holder relative to the complimentary means on said support means.

25. A tool holder as set forth in claim 24 wherein said second means is adapted to permit adjustment of a cutting tool supported by said tool holder, whereby precise adjustment of the axial extension of the tool from the tool holder may be
the clearance area 82 is not critical to the concept of the coupling or uncoupling and may be omitted in certain applications. The inclusion of an open clearance area 82 as depicted in Fig. 6 would not necessarily be desirable when a coolant flow problem would arise because of intercommunication of the clearance areas 82 with measured by said fourth means being juxtaposed a planar surface and measuring from said surface to the outermost point of said cutting tool.

26. A tool holder as set forth in claim 24 including attaching means for fixedly securing said fourth means to said toolholder.

27. A tool holder as set forth in claim 24 wherein said tool holder body has a longitudinal axis, said first means including a bore into which the portion of the tool is received extending coaxially with said longitudinal axis and having an end opening at one end of said body.

28. A tool holder as set forth in claim 27 wherein said fourth means is disposed proximate a plane substantially perpendicular to said longitudinal axis at the other end of said tool holder body.

29. A tool holder as set forth in claim 28 wherein said second means includes at least one screw means extending angularly towards and intersecting the periphery of said bore for engaging the portion of the tool received in the bore.

30. A tool holder as set forth in claim 24 wherein said securing means is a draw bar adapted to extend axially relative to the support means.

31. A tool holder as set forth in claims 24 or 29 wherein said fourth means and said complimentary means each include a plurality of curved teeth.
As an alternative, the coupling portions 66 and 68, depicted in Fig. 3 and 4, may be formed integrally as part of the end of the power driven spindle 42 or tool support (not shown) and the measured by said fourth means being juxtaposed a planar surface and measuring from said surface to the outermost point of said cutting tool.

26. A tool holder as set forth in claim 24 including attaching means for fixedly securing said fourth means to said toolholder.

27. A tool holder as set forth in claim 24 wherein said tool holder body has a longitudinal axis, said first means including a bore into which the portion of the tool is received extending coaxially with said longitudinal axis and having an end opening at one end of said body.

28. A tool holder as set forth in claim 27 wherein said fourth means is disposed proximate a plane substantially perpendicular to said longitudinal axis at the other end of said tool holder body.

29. A tool holder as set forth in claim 28 wherein said second means includes at least one screw means extending angularly towards and intersecting the periphery of said bore for engaging the portion of the tool received in the bore.

30. A tool holder as set forth in claim 24 wherein said securing means is a draw bar adapted to extend axially relative to the support means.

31. A tool holder as set forth in claims 24 or 29 wherein said fourth means and said complimentary means each include a plurality of curved teeth.
selectively designed to engage, in a selective manner, a particular band. In the alternative, engagement of a particular tool or tool holder may be precluded due to an inability of the coupling portion thereon to engage with the coupling portion on the support or spindle. Thus, selectivity as to which cutting tools may be

32. A tool holder as set forth in claim 9 wherein each of said teeth of each plurality includes an inner concave and an outer convex tooth face being so configured that any contact point along both the inner and the outer convex faces has a spiral angle and pressure angle which is equal to that of its corresponding contact point along the respective outer convex and inner concave faces of the other of said fourth means and said complimentary means.

33. A tool holder as set forth in claim 24 including fifth means adapted to be engaged by an external handling mechanism for transporting said tool holder.

34. A tool holder as set forth in claim 24 or 32 wherein said support means is a power driven spindle.

35. A method of adapting a machine tool to engage and drive a shankless tool holder comprising the steps of adapting the spindle of the machine tool to include a coupling member capable of intermeshing in a disengageable and self-centering manner with a toothed cooperative coupling member on a tool or tool holder, providing an engaging mechanism for drawing a tool or tool holder having a toothed cooperative coupling member towards said spindle.

36. The method as set forth in claim 35 wherein the step of adapting is accomplished by machining the face of the spindle to have a toothed coupling formed therein.

37. The method as set forth in claim 35 wherein the step of adapting is accomplished by securing a separate annular
When standardization of variously adapted machine tools is desired the modification of the end of the power driven coupling member in a concentric manner to the face of the spindle.

38. The method as set forth in claim 37 wherein the step of securing is accomplished by bolting of said coupling member to said spindle.

39. The method as set forth in claim 35 including forming each of the teeth on the coupling member with a concave inner face and a convex outer face thereby creating spiral and pressure angles that are generally equal for the inner and outer face of each tooth.

40. The method as set forth in claim 35 including the steps of positioning the bearing controlling the spindle in an optimum location and sizing the bearing to maximize the precision with which said machine tool will operate a tool engaged by said coupling.

41. A method of changing tool holders used with a machine tool comprising the steps of engaging the tool holder to be replaced by a movable means, releasing said tool holder from the spindle, moving the toolholder to be replaced from its in use position proximate the spindle, bringing a replacement tool holder proximate the spindle, positioning said replacement tool holder to permit engagement of a means for drawing said tool holder towards said spindle, engaging a means for drawing said tool holder towards said spindle, drawing said tool holder towards said spindle to thereby establish a rigid drive for said tool holder having substantially zero backlash via said cooperateable radially extending teeth, centering of said tool holder by cooperateable radially disposed teeth responsive to said means for drawing said tool holder towards
speed than the maximum permitted by the machine tool. Clearly
an inefficient situation arises which may be overcome by the
incorporation in the machine tool of the concepts of this
invention. By permitting the use of a smaller bearing thereby
enabling higher rotational speeds of the spindle, it will be

42. A cutting tool substantially as herein particularly described with reference to what is shown in the accompanying drawings.

43. A toolholder substantially as herein particularly described with reference to what is shown in the accompanying drawings.

44. A method of changing toolholders substantially as herein particularly described with reference to what is shown in the accompanying drawings.

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a coupling of this invention associated therewith can engage and support, and in the case of the spindle, drivingly engage, a tool holder or cutting tool having a complimentary portion of the coupling thereon. To accomplish the engagement of the
means providing a positive engagement and self-centering are intended to be contemplated herein.

The specific example of the present invention as shown and described herein is for illustrative purposes only.