Abstract: An automatic installation system for mounting threaded inserts into a work piece, which is operateable in an essentially horizontal plane environment and a method for automatically mounting threaded inserts into a work piece while utilizing such a system.
Automatic installation System and Method for Threaded Inserts

Field of the invention

The present invention is within the field of automatic installation systems for threaded inserts and the methods applied in such systems.

Background of the invention

Threaded inserts are rather prevalent components in the engineering industry in general and even more so in the aerospace industry. Mass volume and assembly of threaded inserts in a plethora of various work pieces - impose high quality and reliability challenges on the mode used for their assembly.

Mechanized, automated mass production systems for assembling threaded inserts are known and in use for many years.

One such system is described, for example, in the WEB site of the German company BOLLHOFF. Its address:


But such systems were found susceptible to reliability problems.

For example, the system is unable to install threaded inserts having small diameters. The system operates in a vertical operating plane. This plane, combined with the vibrations and shocks accompanying its operation, contribute to the loss of small diameter threaded inserts that drop or fall off from their position.

An additional (and even more) serious drawback is that the system is unable to detect that (actually) a threaded insert fell down, was lost or even was never threaded in its intended location - or that it was extracted outwards.

Yet another problem is the following: after the threaded insert was installed in its place within the work piece, the leading tang (tab) at its end has to be trimmed (cut off). The cutting off of the tang naturally leaves behind it a broken remnant (shaving) that must be removed from there (and this removal act is strictly mandatory when the work piece is intended to serve in aeronautical or electronics systems).
Any professional experienced in this field would understand that at times the broken remnant (shaving) might drop (fall into) a hole that is not a "through-hole" (namely not a "passing through" hole - a bore that is not open at its other end).

The system described in the cited advertisement does not treat, or intentionally avoids, the issue of the removal of such a shaving from a hole that is not a through hole.

Thus, a system in accordance with the mentioned prior art known before the present invention, does not provide nor promise the degree of reliability or quality as required in many cases.
Summary of the Invention

In one of its aspects, the present invention constitutes a system for automatic installation of threaded inserts in a work piece, characterized by its operation in an essentially horizontal plane (and not vertical, as the existing systems).

In its preferred embodiment, the system comprises -

a "manipulator" system; and

a rotating head assembly installed at the top of the manipulator system, and includes -

means for grabbing a threaded insert, adjusting and aiming the held threaded insert to its intended location at the work piece and threading it to its intended position in the work piece; and

means for lopping the threaded insert's tang after it has been assembled in the work piece;

means for removing the tang that was cut off from the work piece (in other words - the broken remnant or shaving); and

means for continuous feeding of threaded inserts intended to be grabbed by the means installed at the rotating head; and

optical means for verifying existence / non existence of a threaded insert on the grabbing means installed in the rotating head; and

work bench means for installing the work piece on it; and

a computer system serving to provide command and control of the means cited above.

In a second and different aspect of the invention, the present invention constitutes a method for installing the threaded insert in the work piece that can be automated and implemented through the system that was described briefly above.

In its preferred embodiment, the method comprises the stages of -

grabbing a threaded; and

checking the existence / non existence of a threaded insert on the means that grabbed the threaded insert (and when verification of the grabbing act of said threaded insert does exist) -

adjusting and aiming this threaded insert to its intended location at the work piece; and

threading the threaded insert to its location at the work piece; and
checking the existence / non existence of a threaded insert on the means that grabbed, adjusted and threaded it (the threaded insert) unto its location on the work piece, and when the verification of the non-existence of threading was verified and the removal of the threaded insert from the means was verified as well) - continuation of grabbing cycles, verification, aiming and installing the threaded inserts at the work piece (as long as additional cycles do exist, as said); and

lopping the tang off a threaded insert installed in the work piece (or lopping the tabs of several inserts one after the other – as long as there were additional cycles, as said); and

Removal of the tang that was lopped off from the threaded insert from the work piece (or removal several lopped of tangs one after the other as long as lopping (cutting off) of tangs was performed, as said).

In a third and additional aspect of the invention, the present invention is embodied in a work piece of any given type in which one or more threaded insert/s was/were installed by an automatic installation system as said and or through implementing the method that we pointed at and described succinctly above.
Brief Description of the Accompanying Figures

The present invention will be described herein under in conjunction with the accompanying figures. Identical components, wherein some of them are presented in the same figure - or in case that a same component appears in several figures, will carry an identical number.

**Figure No. 1** constitutes a general view of a system for automatic installation of threaded inserts in a work piece that is in accordance with the present invention.

**Figure No. 2** constitutes a general view of a rotating head assembly that is mounted at the head (top) of a of the manipulator system illustrated in figure No. 1.

**Figure No. 3** constitutes a general view of a means for continuous feeding of threaded inserts so that they will be grabbed by a means that is mounted in the rotating head assembly illustrated in Fig. No. 2.

**Figure No. 4** constitutes a side view of the means for continuous feeding of threaded inserts illustrated in Fig. No. 3.

**Figure No. 5** constitutes a cross section schematic view of a means for grabbing a threaded insert, aiming the threaded insert that was grabbed to its intended location in the work piece and threading it unto its intended location in the work piece located in the rotating head assembly that is the illustrated in Figure No. 2.

**Figure No. 6** constitutes a schematic cross section view of a means for lopping (cutting off) the tab of a threaded insert after it has been assembled in a work piece that is mounted in the rotating head assembly illustrated in Fig. No. 2.

**Figure No. 7** constitutes a schematic cross section view of a means for removing the tab that was cut off from the work piece that is mounted in the rotating head assembly as illustrated in Fig. No. 2.

**Figure No. 8** constitutes a flow chart diagram describing the various stages (steps) of the method for installing the threaded inserts in the work piece that is amenable to be automated through implementing the system that is illustrated in figures No. 1 to No. 7, inclusive.
Attachment A constitutes 13 photographs marked A-I to A-I3 of a prototype of a system in accordance with the invention. The system, whose photographs are included herein, implements the method as embodied in accordance with the invention.
Detailed Description of a Preferred embodiment of the Present Invention

Reference is being made below to the figures numbered 1 to 8 and to the attached photographs designated attachment A.

From viewing and studying Figure No. 1, any professional experienced in the field would understand that the present invention constitutes a system 10 for automatic installation of threaded inserts (that is not illustrated) in a work piece 12. System 10 is characterized by that it operates in an essentially horizontal plane environment (rather than the common systems - operating in a vertical plane set up).

It has been found that operating the system in essentially a horizontal plane is preferable in comparison to that of operating in the vertical plane as it, inter alia, reduces the occurrences of falling and lost threaded inserts from the end of the means that threads them unto their intended place in the work piece (as a result of their weight (free fall) and the vibrations and shock inherent in the operation of such systems). Moreover, thus system 10 enables installing threaded inserts of a relatively small diameter - in a system in accordance with the invention this means that use of threaded inserts whose diameter essentially equals their length was enabled.

In the embodiment illustrated in figure 1, that of course constitutes solely an example to a system in accordance with the present invention, the system comprises -

a manipulator system 15; and

a rotating head assembly 20 that is installed at the top (head) of the manipulator system 15, and it comprises -

grabbing means 25 for grabbing the threaded insert, adjusting and aiming the threaded insert that has been grabbed to its intended location at the work piece 12, and threading it into its intended location in the work piece; and

means 30 for cutting off (lopping) the leading tab (tang) of the threaded insert after it has been installed in the work piece; and

means 35 for removing from the work piece the tang that was severed from the insert; and
means 40 for providing continuous feeding of threaded inserts intended to be
grabbed by means 25 that is installed at the rotating head 20; and

optical means 45 for verifying the existence / non existence of a threaded insert on
the means 25 that is installed in the rotating head 20; and

work bench means 50 for installing the work piece 12 on it; and

a computer system 55 serving to provide command and control of the systems and
means cited above.

Any experienced professional in this field would understand that manipulator
system 15 might be based on a standard industrial robot equipped with and provided for
several (4, 5 or 6) degrees of freedom.

Let's refer to **Fig.** No. 2. Fig. 2 constitutes a rotating head assembly 20 that is
mounted at the head (top) of the manipulator 15. It enables rotation and exchanging means
such as 25, 30 and 35, and inter-exchanging and operating them one after the other.

Means 25 is utilized, as said, for grabbing a threaded insert, aiming the threaded
insert that was grabbed to its intended location in the work piece 12 and threading it into
its place in the work piece.

Let's refer now to **Fig.** No. 5. Figure 5 presents an example of means 25 designed
to adjust and accurately train itself to the threaded insert to be grabbed - relying on a
wobbling motion of its tip. In other words grabbing means 25 is designed to approach the
threaded inserts to be taken, while performing a wobbling motion of the tip of said means
(see the illustrated arrows). Thus self-adjustment on the edge of the wound wire of which
the threaded insert is composed becomes possible, together with centering the thread head
of the relevant means to its accurate position relative to the axis of the threaded insert.

Any experienced professional would appreciate that the wobbling motion maybe
implemented while utilizing variety of common grabbing means that widely differ in their
internal design (which is rather routine) from the one that is depict in figure 5 and from
each other, but at the same time - the provided wobbling phenomena will be appreciated
as the key factor enabling the task (and therefore defined as a further characterized feature
of the exemplified system 10).

Any experienced professional would understand that means 25 might be
commanded and controlled from the point of view of the number rotations of threaded
head (top), the intensity of the force exerted on the means as it moves forwards or backwards, the sense ("direction") of the rotation of threaded insert's head and the resistance it encounters.

Means 30 serves, as noted, for cutting off the tangs of the threaded inserts after they are installed in work piece 12. Any professional will understand that such cutting off means 30 may be implemented by providing a linear motion pneumatically movable puncher (of a routine design).

Turning our attention to figure no. 7 (presenting a schematic view of a means for extracting / removing the tang), it is found that means 35 might be made of a bisected (halved) tubule 710.

Pressurized air is made to flow through one path 715 in the tubule. This path is located facing the center of the threaded insert that was installed in a bore that is not a trough hole.

The airflow generates a vortex at the base of the bore. This turbulence drives the residue tang (tab) 777 which was cut off from the threaded insert "to fly" out of the bore.

The tang piece is driven away and sucked into the other path - 720. This path is formed in the tubule and located along the first path 715.

Vacuum conditions might be generated in this second path 720 that helps to remove the small remnant pieces "uphill" in the second path of the tubule.

A relatively little sack ("bag") 725 that is installed on the way up of the second path 720 collects into it the severed tang (in the same manner as the hose/bag combination of a vacuum cleaner).

Any professional experienced in this field would understand that along the second path of the tubule - through which passes the cut off tang pieces, wherein along the pieces that were mixed under the air pressure, there might be installed a sensor means 730.

The task of this sensor means 730 is to provide and pass indications to the command and control unit 55. Such an indications might provide a measure (level) of certainty that indeed, from the specific bore in which the treaked insert was installed; the broken tang was indeed sucked and removed. A suitable sensor 730 might be an optical sensor, such as a photoelectric cell or CCD CMOS camera type of devices that would detect the shaving tang as it passes its field of view and provide such indication.
Means 40 serves, as said for continuous feeding of threaded inserts, meant to be grabbed by means 25 that is assembled in the rotating head 20.

Means 40 might be made to use commercially sold rolls of threaded inserts. They might be, for example, commercially marketed rolls made of a plastic material, carrying threaded inserts on their surface (and see, for example, at the WEB site of the aforementioned German company BOLLHOFF).

Naturally, using such commercial rolls might lead to errors of localization of the inserts or other failures when trying to use them in automated systems - for example, due to variations in height or different location of the envelope or edges of the threaded inserts, on the roll, or —considering another example of potential difficulty —due to the flexibility and possible elongation of the plastic carrier material from which the band carrying the threaded inserts on its surface is made.

Let's refer now to figures No. 3 and No. 4 that we have temporarily skipped. In means 40, there is included an example of a structure that compensates and offsets the localizing errors.

Driving array 310 pushes (by friction) and advance band 333, through contact on the outer surfaces of the threaded insert on both of its sides.

This driving array is synchronized with the operation of the manipulator system so that when the task of advancing and pushing the roll is finished, means 25 might self adjust itself accurately to handle the grabbing of the threaded insert.

A photoelectric sensor 320 might provide the required indications to the aforementioned control system that verily a threaded insert was indeed grabbed and extracted from the band's surface.

Positioning a weight at the end of roll's band might help in leading the emptied band and removing it from the system's vicinity after the threaded inserts were grabbed one after the other and extracted from it.

Optical means 45 serves, as said, to examine existence / non-existence of a threaded insert on the means 25 that is installed in the rotating head 20.

Any professional experienced in this field would appreciate the fact that integrating this means in the system would contribute significantly to the system's quality and reliability levels. Thus for example, if grabbing an insert from the roll was actually
concluded with the threaded insert falling down from the end of means 25, then optical means 45 would detect this fact and transfer the appropriate indication to the control system.

Any experienced professional would understand that optical means 45 might be based on using a CCD or CMOS camera, combined with an appropriate widely known image processing algorithm.

As we shall describe below, when referring to the method that is implemented in system 10, the same optical means 45 might also serve for an additional purpose, namely - verifying that the threaded insert was indeed separated from the end of means 25 after it has been threaded unto its intended spot in work piece 12.

Work bench means 50 serves, as said, for affecting the installation of work piece 12 on its surface. The work bench might be a rotating one, in a manner that enables setting up two work pieces simultaneously on its two sides, and thus it becomes possible to safely assemble/ disassemble one of the work pieces on while the system is engaged with the other work piece on the other side of the bench.

As mentioned earlier, in another, second and different aspect of it, the present invention constitutes a method for setting up threaded inserts in a work piece that is amenable to automated operation and its implementation through employing a system as described above with reference to figures No. 1 through No. 7 and to the accompanying added pictures (Attachments A).

Let's refer to Figure No. 8. Figure 8 describes - by way of presenting a flow chart diagram - the various stages (steps) of a preferred embodiment 810 of the innovative method. Method 810 comprises -

Stage 815 - the stage of grabbing a threaded insert; and

Stage 820 - the stage of checking and verifying the existence / non-existence of a threaded insert on the means that grabbed, as said, the threaded insert.

When indeed, verification of the grabbing act of a threaded insert proved positive - see track 822 and proceed accordingly.

Stage 825- the stage of adjusting and aiming the threaded insert that was grabbed - to its intended position in the work piece; and
Stage 830 - the stage of threading the threaded insert into its location at the work
piece; and

Stage 835 - the stage of checking the existence / non-existence of a threaded insert
on the means that grabbed, adjusted and threaded it (the threaded insert) unto its location
on the work piece; and

If the verification of the threading was verified and the removal of the threaded
insert from the means was verified as well - see track 837 and proceed whence -

Checking whether there exists additional setting up tasks for the specific work
piece (stage 838), and if there exist - see track 839 —

Continuation of the cycles of grabbing, verification, aiming and installing of the
threaded inserts at the work piece (as long as additional cycles do exist, as said); and

upon the termination of the setting up cycles — see track 839' —

Stage 840 - the stage of lopping the tang off a threaded insert that is assembled /
installed in the work piece; and

Checking whether additional cycles of setting up threaded inserts in the work
piece (stage 841), and if so - see track 842 -

Lopping several tangs one after the other - as long as there existed additional
cycles, as said; and

Stage 845, the stage of removal from the work piece of the tang that was lopped
off from the threaded insert; and

Checking whether additional cycles of setting up threaded inserts in the work
piece that require removal of the lopped tangs do exist (for example, in case of a threaded
inserts mounted into bores that are not a through holes), (stage 846), and if so - see track
847 -

Removal of several lopped (cut off) tangs one after the other as long as additional
lopping / cutting off operations were performed, as said.

Any professional experienced in this field would understand that the stages of
method 810 are amenable to computerized programming and control by using the
aforementioned computer system 55.
Similarly, any experienced professional would also understand that the method might incorporate additional stages, such as, for example, stages of -

Advancing the means that serves for continuous feeding of the threaded inserts in order to grab them, and/or a stage of

Turning the workbench that serves as the basis for positioning the work piece on its surface (when resorting to use a two sided work bench).

Any professional would understand that the present invention was described above solely in a way of presenting examples, serving our descriptive needs and those changes or variants in the structure of the automatic installation system for mounting threaded inserts into a work piece and its method - the subject matter of the present invention, would not exclude them from the framework of the invention.

In other words, it is feasible to implement the invention as it was described above while referring to the accompanying figures and pictures, also with introducing changes and additions that would not depart from the constructional characteristics of the invention, characteristics that are claimed herein under.
CLAIMS

1. An automatic installation system for mounting threaded inserts into a work piece, comprising —

a manipulator type of system; and

a rotating head assembly installable at the top of said manipulator system, and includes -

grabbing means for grabbing a threaded insert, adjusting and aiming the held threaded insert to its intended location at the work piece and threading it to its intended position in the work piece; and

cutting off means for lopping the threaded insert's tang after it has been assembled in the work piece; and

removing means for removing the tang that was cut off from the work piece; and

feeding means for continuous feeding of threaded inserts intended to be grabbed by said means installed at the rotating head; and

optical means for verifying existence / non existence of a threaded insert on the grabbing means installed in said rotating head; and

work bench means for installing the work piece on it; and

a computer system serving to provide command and control of the means cited hereinafore; and

wherein said automatic installation system is characterized by that it operates in an essentially horizontal plane environment.

2. An automatic installation system for mounting threaded inserts into a work piece, in accordance with claim 1, further characterized by said grabbing means formed with a tip and enabling wobbling motion of said tip.

3. An automatic installation system for mounting threaded inserts into a work piece, in accordance with claim 1, further characterized by said removing means formed with a bisected tubule enabling for generating of vortex type of airflow for driving the
residue tang of the threaded insert "to fly" out of the bore wherein said threaded insert was mounted.

4. An automatic installation system for mounting threaded inserts into a work piece, in accordance with claim 3, wherein said removing means further comprising a sensor means for providing indication if the broken tang was indeed removed.

5. An automatic installation system for mounting threaded inserts into a work piece, in accordance with claim 1, wherein said feeding means comprising a driving array enabling frictionally pushing and advancing a band of commercially sold roll of threaded inserts.

6. An automatic installation system for mounting threaded inserts into a work piece, in accordance with claim 1, wherein said work bench means is of the rotating type enables setting up two work pieces simultaneously on its two sides.

7. A method for automatically mounting threaded inserts into a work piece comprising the stages of-

  grabbing a threaded insert; and

  checking and verifying the existence / non-existence of a threaded insert on a means that grabbed, as said, the threaded insert; and

  adjusting and aiming the threaded insert that was grabbed— to its intended position in a work piece; and

  threading the threaded insert into its location at the work piece; and

  checking the existence / non-existence of a threaded insert on the means that grabbed, adjusted and threaded it unto its location on the work piece; and

  lopping the tang off a threaded insert that is installed in the work piece; and

  removing from the work piece of the tang that was lopped off from the threaded insert; and wherein said method for automatically mounting threaded inserts into a work piece is characterized by -

  said stages are preformed in an essentially horizontal plane environment.

8. A method for automatically mounting threaded inserts into a work piece in accordance with claim 7 wherein at least one of said stages of grabbing a threaded
insert and adjusting and aiming the threaded insert that was grabbed is performed while wobbling the threaded inserts.

9. A method for automatically mounting threaded inserts into a work piece in accordance with claim 7 wherein said stage of removing from the work piece of the tang that was lopped off from the threaded insert is performed while exposing said tang to a vortex type of airflow and "flaying" it into a collecting bag.

10. A work piece mounted with at least one threaded insert that was mounted therein while utilizing an automatic installation system that was at least substantially in accordance with either one of claims 1 - 6.

11. A work piece mounted with at least one threaded insert that was mounted therein while implementing a method that was at least substantially in accordance with either one of claims 7 - 9.
Attachment A – A8

STEP 840
Attachment A – A12