Abstract Title: Press fitting method and apparatus

An apparatus for press-fitting a valve seat 10 and a valve guide 12 into a plurality of press-fitting sections 4a, 4b formed on a cylinder head 4 comprises a valve seat holder 14 and a valve guide holder 16 moveably holding the valve seat 10 and the valve guide 12 in the uniaxial direction; cylinder head securing jigs 15, 17 provided with a plurality of these holders 14, 16 for positioning the cylinder head 4, and a C-type pressure jig 3 for press-fitting the valve seat 10 and the valve guide 12 held by the holders 14, 16 provided on these cylinder head securing jigs 15, 17 into the press-fitting sections 4a, 4b in order. The C-type pressure jig 3 is mounted on an arm edge section 2 of an articulated robot 1 through a floating mechanism 40.

Fig. 1

Fig. 4
PRESS FITTING METHOD AND APPARATUS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a method and apparatus for press-fitting a press-fitting object member (such as a valve seat and a valve guide) into a press-fitting member (such as a cylinder head).

2. Description of the Prior Art

To press-fit a press-fitting object member (such as a valve seat and a valve guide) into a press-fitting member (such as a cylinder head), a method for press-fitting by lowering a valve guide press-fitting device which can move vertically supporting the valve guide, relative to a cylinder head fixedly positioned on a swingable jig seat, from above the cylinder head and by raising a valve seat press-fitting device which can move vertically supporting the valve seat, from below of the cylinder head, is known (for example, refer to Patent Document 1).

Also, a device for press-fitting a valve seat in a condition in which the center deviation between a valve seat and a press-fitting section of a cylinder head (a valve seat fitting hole) is controlled is known (for example, refer to Patent Document 2).


Referring to the device disclosed in Patent Document 1, if the press-fitting position of the valve guide press-fitting device when the valve guide is press-fitted and the press-fitting position of the valve seat press-fitting device when the valve seat is press-fitted are not accurate, there is a possibility that the press-fitting will be inadequate and the press-fitting object member or the press-fitting member could be damaged.

Referring to the device disclosed in Patent Document 2, a mechanism for feeding the valve guide and the valve seat to the end or a mechanism for holding the valve guide and the valve seat at the end becomes complicated and thus, there is a
problem in that the device becomes large and complicated. Further, by making the device large and complicated, if the position, angle and the like of the press-fitting section of the cylinder head vary according to the change of design and the like, the device must also be changed in a large way and as a result, there is a problem in that this drives up costs markedly.

**SUMMARY OF THE INVENTION**

It is therefore an object of the present invention to provide a press-fitting method and apparatus of a simple structure which can solve the problems stated above, respond flexibly to a change of design and the like of the press-fitting member and press-fit a press-fitting object member smoothly.

In order to attain this object, according to the first aspect of the present invention, a method for press-fitting a press-fitting object member into a plurality of press-fitting sections formed on a press-fitting member is provided, which comprises the steps of: setting the press-fitting object member in a condition in which it can move in the uniaxial direction; positioning the set press-fitting object member in a position facing the press-fitting sections; and press-fitting the positioned press-fitting object member into the press-fitting sections in order.

According to the second aspect of the present invention, an apparatus for press-fitting a press-fitting object member into a plurality of press-fitting sections formed on a press-fitting member is provided, which comprises: a holding means for moveably holding the press-fitting object member in the uniaxial direction; a securing means provided with a plurality of holding means for positioning the press-fitting member; and a pressing means for press-fitting the press-fitting object member held by the holding means formed on the securing means into the press-fitting sections in order.

In the second aspect of the present invention, the pressing means can be composed of an industrial robot, and a C-type pressure jig mounted on the industrial robot for press-fitting two press-fitting object members, held to mutually face the press-fitting object member holding means, into the respective press-fitting sections.
The C-type pressure jig can be mounted on the industrial robot through a floating mechanism.

Further, the C-type pressure jig can be disposed to cause push rods, respectively pressing the two press-fitting object members, to face each other. Still further, two C-type pressure jigs can be mounted on the industrial robot.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other objects, features and advantages of the present invention will become more apparent from the following description when taken in conjunction with the accompanying drawings.

Fig. 1 is a schematic plan view of a press-fitting apparatus according to the present invention;

Fig. 2 is a schematic side view of the press-fitting apparatus according to the present invention;

Fig. 3 is a schematic front view of the press-fitting apparatus according to the present invention;

Fig. 4 is a cross-sectional view in a condition in which a cylinder head is positioned in a valve seat set jig holding a valve seat and a valve guide set jig holding a valve guide;

Fig. 5 is an enlarged view of a shift unit (in an introduction position) as shown in Fig. 2, wherein Fig. 5a shows a condition in which the cylinder head and the set jig are unclamped and Fig. 5b shows a condition in which the cylinder head and the set jig are clamped; and

Fig. 6 is a view explaining the operation of a C-type pressure jig.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

A preferred embodiment of the present invention will now be described with reference to the accompanying drawings. Fig. 1 is a plan view of a press-fitting apparatus according to the present invention, Fig. 2 is a schematic side view of the
press-fitting apparatus, and Fig. 3 is a schematic front view of the apparatus. Fig. 4 is a cross-sectional view of the apparatus in a condition in which a cylinder head is positioned in a valve seat set jig holding a valve seat and a valve guide set jig holding a valve guide. Fig. 5 is an enlarged view of a shift unit (in an introduction position) as shown in Fig. 2, and Fig. 6 is a view explaining the operation of a C-type pressure jig.

A press-fitting apparatus according to the present invention is an apparatus for press-fitting a valve seat and a valve guide into a plurality of press-fitting sections formed on a cylinder head at the same time and comprises, as shown in Figs 1 through 3, an articulated robot 1, a C-type pressure jig 3 mounted on an arm edge section 2 of the articulated robot 1, and a set jig 5 for fixedly positioning a cylinder head 4 and holding the valve seat and the valve guide in the desired position.

For the press-fitting operation using the present apparatus, an introduction station A for introducing the cylinder head 4, an exhaust side press-fitting station B for press-fitting the valve seat and the valve guide into an exhaust side of the cylinder head 4, an idle station C for buffering, an intake side press-fitting station D for press-fitting the valve seat and the valve guide into the intake side of the cylinder head 4, and a withdrawing station E for withdrawing the cylinder head 4 after completion of the press-fitting operation, are formed.

Provided on the exhaust side press-fitting station B are an introduction position B1 for setting the valve seat and the valve guide on the set jig 5 and fixedly positioning the cylinder head 4 on the set jig 5, and a press-fitting position B2 for conducting the press-fitting operation on the exhaust side by the C-type pressure jig 3. Provided on the intake side press-fitting station D are an introduction position D1 for introducing the cylinder head 4 whereby the press-fitting operation on the exhaust side is completed, and a press-fitting position D2 in which the press-fitting operation on the intake side is conducted by the C-type pressure jig 3.

The transfer of the cylinder head 4 fixedly positioned on the set jig 5 between the introduction positions B1, D1 and the press-fitting positions B2, D2 is performed by a shift unit 7. The shift unit 7 is driven by the forward and backward operation of a
cylinder 8. Reference numeral 9a as shown in Fig. 3 is a resin rail laid down for smoothly conveying the cylinder head 4 and reference numeral 9b is a guide bar for guiding the conveying direction of the cylinder head 4 and positioning the cylinder head 4.

The set jig 5 is provided in the shift unit 7 and is composed of a valve seat set jig 11 for setting a valve seat 10 and a valve guide set jig 13 for setting a valve guide 12, as shown in Fig. 4. Fig. 4 shows a condition in which after press-fitting the valve seat 10 and the valve guide 12 on the exhaust side, the valve seat 10 and the valve guide 12 on the intake side are set on the set jig 5.

The valve seat set jig 11 is composed of a plurality of valve seat holders 14 for movably holding the valve seat 10 in the uniaxial direction, and a cylinder head fixing jig 15 for fitting each valve seat holder 14 therein and fixedly positioning the cylinder head 4 to allow the valve seat 10 held by each valve seat holder 14 to face a press-fitting section 4a. In a preferred embodiment of the present invention, the cylinder head 4 into which 16 valve seats 10 and 16 valve guides are press-fitted is referred to as a press-fitting member.

The valve guide set jig 13 is composed of a plurality of valve guide holders 16 for movably holding the valve guide 12 in the uniaxial direction, and a cylinder head securing jig 15 for fitting each valve guide holder 16 therein and fixedly positioning the cylinder head 4 to allow the valve guide 12 held by each valve guide holder 16 to face a press-fitting section 4b. As shown in Fig. 5b, the cylinder head 4, the valve seat set jig 11, and the valve guide set jig 13 are secured to the shift unit 7 by the backward operation of a clamp cylinder 50 described later.

The valve seat holder 14 is composed of a rod 20 for mounting the valve seat 10 on the front edge section 20a, a cylindrical guide member 21 slidably guiding the rod 20 and fitted into an installation opening 15a of the cylinder head securing jig 15, and a spring 22 for biasing the rod 20 in the backward direction. Reference numeral 20b is a fall-out prevention stopper formed on the rod 20 and reference numeral 20c is a stopper formed on the rod 20 for compressibly holding the spring 22.
The valve guide holder 16 consists of a substantially cylindrical guide member 25 adapted to receive the valve guide 12 for setting, and fitted into an installation opening 17a of the cylinder head securing jig 17, and a bolt 26 for securing the guide member 25 to the cylinder head fixing jig 17. An opening section of the guide member 25 on the valve guide inserting side is provided with a tapered section 25a for smoothly receiving the valve guide 12. Reference numeral 17b is a fall-out prevention stopper for the valve guide 12. The end of the stopper 17b is a ball plunger projecting inside the guide member 25. The cylinder head securing jigs 15, 17 are respectively provided with knock pins 15c, 17c which are fitted into knock holes 4c, 4c of the cylinder head 4. With this arrangement, the central axis of the valve seat holder 14 accurately corresponds with the central axis of the valve guide holder 16.

The C-type pressure jig 3 is provided, as shown in Fig. 6, with a C-type frame 30, a pressure cylinder 31 provided on one end of the C-type frame 30, a press-fitting head 33 provided on the front edge of a piston rod 32 of the cylinder 31, a valve guide push rod 34 installed upright on the press-fitting head 33, and a valve seat push rod 35 provided on the other end of the C-type frame 30. The valve guide push rod 34 and the valve seat push rod 35 are provided to face each other and the central axes of these two rods are in line with each other. The front edge section of the valve seat push rod 35 pressing the stopper 20c of the rod 20 is formed to have a substantially hemispheric shape so that it can correspond even though a teaching point of the articulated robot 1 slightly deviates. Reference numeral 36 is a guide rod for the piston rod 32.

The press-fitting head 33 is provided with a measuring machine (not shown) for measuring the press-fitting position, while the valve seat push rod 35 is incorporated with a load cell (not shown) for measuring the load. Since the press-fitting operation can be performed while measuring the press-fitting position and the load using the measuring meter and the load cell, it is possible to detect an acceptable or unacceptable hole diameter of the press-fitting sections 4a, 4b of the cylinder head 4 and to measure the press-fitting depth as well.

The C-type pressure jig 3 is mounted on the arm edge section 2 of the
articulated robot 1 through a floating mechanism 40. The floating mechanism 40 is composed of a base member 41 secured to the arm edge section 2, a guide rod 42 supported by the base member 41, a substantially cylindrical slide member 43 adapted to fit the guide rod 42 therein and secured to the C-type frame 30, and a spring 44 compressibly inserted between the base member 41 and the slide member 43. Since the C-type pressure jig 3 is floatably moved in the arrow direction through the floating mechanism, a load is hardly imposed on the articulated robot 1 during press-fitting.

Operation and press-fitting method of the press-fitting apparatus according to the present invention as constructed above will now be described. First, an operator sets eight (8) valve seats 10 on the valve seat holder 14 of the valve seat set jig 11, which is standing ready in the exhaust side press-fitting station B, on the exhaust side. Likewise, the operator sets eight (8) valve guides 12 on the valve guide holder 16 of the valve guide set jig 13 on the exhaust side (i.e., press-fitting object member setting step).

Next, as shown in Fig. 5a, the cylinder head 4 is conveyed from the introduction station A to the shift unit 7 of the exhaust side press-fitting station B using the resin rail 9a and the guide bar 9b. At this point, the cylinder head 4 is mounted on the resin rail 9a and is inserted between the guide bars 9b, 9b. The cylinder head 4 and the set jig 5 are in the unclamping condition because the clamp cylinder 50 is in a forward condition. The shift unit 7 consists of an immovable section such as the valve seat set jig 11 and the guide bar 9b, and a movable section such as the valve guide set jig 13 and the resin rail 9a which can move vertically by the elevating operation of the clamp cylinder 50. Reference numeral 51 is a rail and 52 is a guide.

Next, when the clamp cylinder 50 is moved backwards (i.e., clamp operation), the resin rail 9a comes down to depart from the cylinder head 4, wherein the cylinder head 4 touches the valve seat set jig 11 for positioning. The valve guide set jig 13 comes down further to touch the cylinder head 4, wherein the cylinder head 4 is positioned (i.e., press-fitting object member positioning step). Thus, as shown in Fig. 5b, the cylinder head 4, the valve seat set jig 11, and the valve guide set jig 13 are secured to the shift unit 7.
Next, the cylinder head 4 is fixedly positioned by the valve seat set jig 11 and the valve guide set jig 13 moves from the introduction position B1 of the exhaust side press-fitting station B to the press-fitting position B2 by the shift unit 7. Thus, the C-type pressure jig 3 mounted on the arm edge section 2 of the articulated robot 1 is positioned at the pre-taught point and in the pre-taught position.

As shown in Fig. 6, the cylinder 31 is driven to allow the valve guide push rod 34 to press the valve guide 12 and to allow the valve seat push rod 35 to press the rod 20 of the valve seat holder 14, wherein the valve seat 10 and the valve guide 12 are respectively press-fitted into the press-fitting sections 4a, 4b of the cylinder head 4 (i.e., press-fitting object member press-fitting step). In a preferred embodiment of the present invention, two (2) places can be press-fitted at the same time because two (2) C-type pressure jigs 3 are mounted in parallel on the arm edge section 2. In this manner, all the valve seats 10 and valve guides 12 on the exhaust side can be press-fitted with four press-fitting operations.

Although the valve seat 10 and the valve guide 12 are press-fitted at the same time, a load is hardly imposed on the articulated robot 1 because the C-type pressure jig 3 is mounted on the arm edge section 2 through the floating mechanism. Further, the positioning accuracy of the articulated robot 1 is not so severe because the valve guide 12 is press-fitted through the valve guide push rod 34 and the valve seat 10 is press-fitted through the valve seat push rod 35. Teaching of the articulated robot 1 is easy because press-fitting can be performed even though the positioning of the articulated robot 1 deviates by, for example, 1 mm.

Further, since the press-fitting head 33 is provided with a measuring meter (not shown) for measuring the press-fitting position, while the valve seat push rod 35 is incorporated with a load cell (not shown) for measuring the load, the press-fitting operation can be performed measuring the press-fitting position and the load. It is therefore possible to detect an acceptable or unacceptable hole diameter of the press-fitting sections 4a, 4b of the cylinder head 4 and to measure the press-fitting depth as well.
Next, when all the valve seats 10 and the valve guides 12 on the exhaust side are press-fitted, the cylinder head 4 is moved from the press-fitting position B2 of the exhaust side press-fitting station B to the introduction position B1 by the shift unit 7. Then, the cylinder head 4, the valve seat set jig 11 and the valve guide set jig 13 are released from the shift unit 7 by the forward operation (i.e., unclamp operation) of the clamp cylinder 50 and are withdrawn to the idle station C.

Then, in the intake side press-fitting station D, all the valve seats 10 and the valve guides 12 on the intake side are press-fitted into the press-fitting sections 4a, 4b of the cylinder head 4 in the same manner as the press-fitting operation conducted in the exhaust side press-fitting station B. Thus, the cylinder head 4 into which the valve seat 10 and the valve guide 12 on both the exhaust side and the intake side are press-fitted is withdrawn to the withdrawing station E to complete the press-fitting operation. It is optional which of the exhaust side and the intake side should be press-fitted first. It is to be noted that the set jig 5 can be formed separately on the exhaust side and the intake side or be formed integrally.

In the case where the types of models are changed, the set jig 5 consisting of the valve seat set jigs 11 and the valve guide set jig 13 is only changed to the types which are the object of press-fitting because the C-type pressure jig 3 can be controlled to the desired location and position by teaching of the articulated robot 1. Also, the installation pitch of the two C-type pressure jigs 3 can be changed manually or automatically.

**EFFECTS OF THE INVENTION**

According to the first aspect of the present invention, since the press-fitting object member held in a condition in which it can move in the uniaxial direction is pressed in a position close to the press-fitting section formed on the press-fitting member, it is possible to press-fit the press-fitting object member into the press-fitting section smoothly and accurately.

According to the second aspect of the present invention, since the press-fitting
object member held in a condition in which it can move in the uniaxial direction is pressed by the pressing means in a position close to the press-fitting section formed on the press-fitting member, positioning of the pressing means with a high degree of accuracy is unnecessary. The mechanism of the pressing means can be simplified because supply of the press-fitting object member to the pressing means and retention of the press-fitting object member is unnecessary.

Further, according to the present invention, it is unnecessary to change the position of the press-fitting member and a simpler structure can be realized because the position of the C-type pressure jig can be changed according to the location and press-fitting direction of the press-fitting object member. Even though the shape of the press-fitting member and the location of the press-fitting section are changed due to a change of design, it is possible to respond only by changing the press-fitting member securing means, and contribute to the cost reduction.

Still further, according to the present invention, a bad influence is not exerted on the industrial robot because a load is hardly imposed on the industrial robot during the press-fitting operation thanks to the floating mechanism.

According to the present invention, the industrial robot does not require high positioning accuracy because the press-fitting object member is pressed through the push rod and as a result, teaching of the industrial robot is easy.

Further, in the present invention, it is possible to perform the press-fitting operation with rapidity because the press-fitting operation can be conducted in two locations at the same time.

**INDUSTRIAL APPLICABILITY**

If the pressing means is composed of the C-type pressure jig mounted on the industrial robot, the correspondence to the change of models can be easily made by teaching of the industrial robot. As a result, the expansion of applicability to the press-fitting operation is expected.
What is claimed is:

1. A press-fitting method for press-fitting a press-fitting object member into a plurality of press-fitting sections formed on a press-fitting member comprising the steps of:

   setting the press-fitting object member in a condition in which it can move in the uniaxial direction;

   positioning the set press-fitting object member in a position facing the press-fitting sections; and

   press-fitting the positioned press-fitting object member into the press-fitting sections in order.

2. A press-fitting apparatus for press-fitting a press-fitting object member into a plurality of press-fitting sections formed on a press-fitting member comprising:

   a holding means for moveably holding the press-fitting object member in the uniaxial direction;

   a securing means provided with a plurality of holding means for positioning the press-fitting member; and

   a pressing means for press-fitting the press fitting object member held by the holding means formed on the fixing means into the press-fitting sections in order.

3. The press-fitting apparatus according to claim 2, wherein the pressing means comprises an industrial robot and a C-type pressure jig mounted on the industrial robot for press-fitting two press-fitting object members, held to mutually face the press-fitting object member holding means, into the respective press-fitting sections.

4. The press-fitting apparatus according to claim 2, wherein the C-type pressure jig is mounted on the industrial robot through a floating mechanism.

5. The press-fitting apparatus according to claim 3 or claim 4, wherein the C-type pressure jig is disposed to cause push rods respectively pressing the two press-fitting object members to face each other.

6. The press-fitting apparatus according to any one of claims 3 through 5, wherein two C-type pressure jigs are mounted on the industrial robot.
**Application No:** GB0707741.5  
**Examiner:** Tony Martin  
**Claims searched:** All claims  
**Date of search:** 15 August 2007

### Patents Act 1977: Search Report under Section 17

#### Documents considered to be relevant:

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| X        |                    | JP2004116414 A  
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| X        |                    | US6467154 B  
            |                    | Unova see claim 1  |
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Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC

Worldwide search of patent documents classified in the following areas of the IPC

B23P

The following online and other databases have been used in the preparation of this search report

On line databases WPI, EPDOC

International Classification:

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