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U1S S1820 S1969

(56) Documents Cited
GB 1473809 A GB 1456169 A GB 1086379 A
GB 1009400 A

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(54) Component assembly machine

(57) A machine for assembling a heat exchanger of the type commonly used for motor vehicle radiators comprises a generally rectangular working table 4, press plates 6 and a stop 42. The components of the radiator are acted upon by the press plates mounted on roller screws 22 which are driven by electric servo motors 32. The extent of travel of the press plates 6 is measured by sensing devices which allows a computer, which controls the actuation of the servo motors 32, to calculate the position of the press plates precisely, and thus to control their translation such that radiators are repeatedly uniformly constructed. The time taken to produce a single radiator is also drastically reduced.

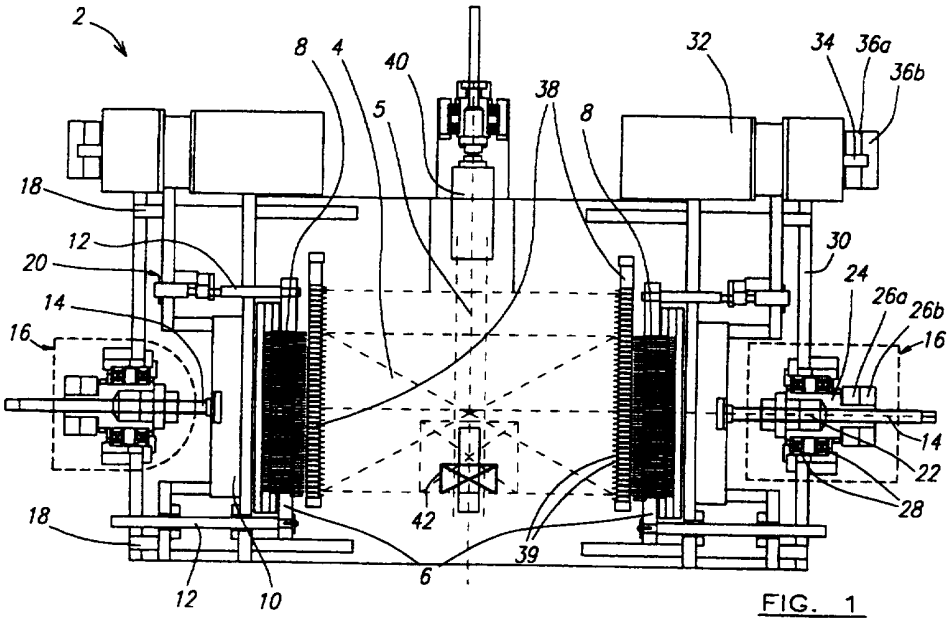

FIG. 1

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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

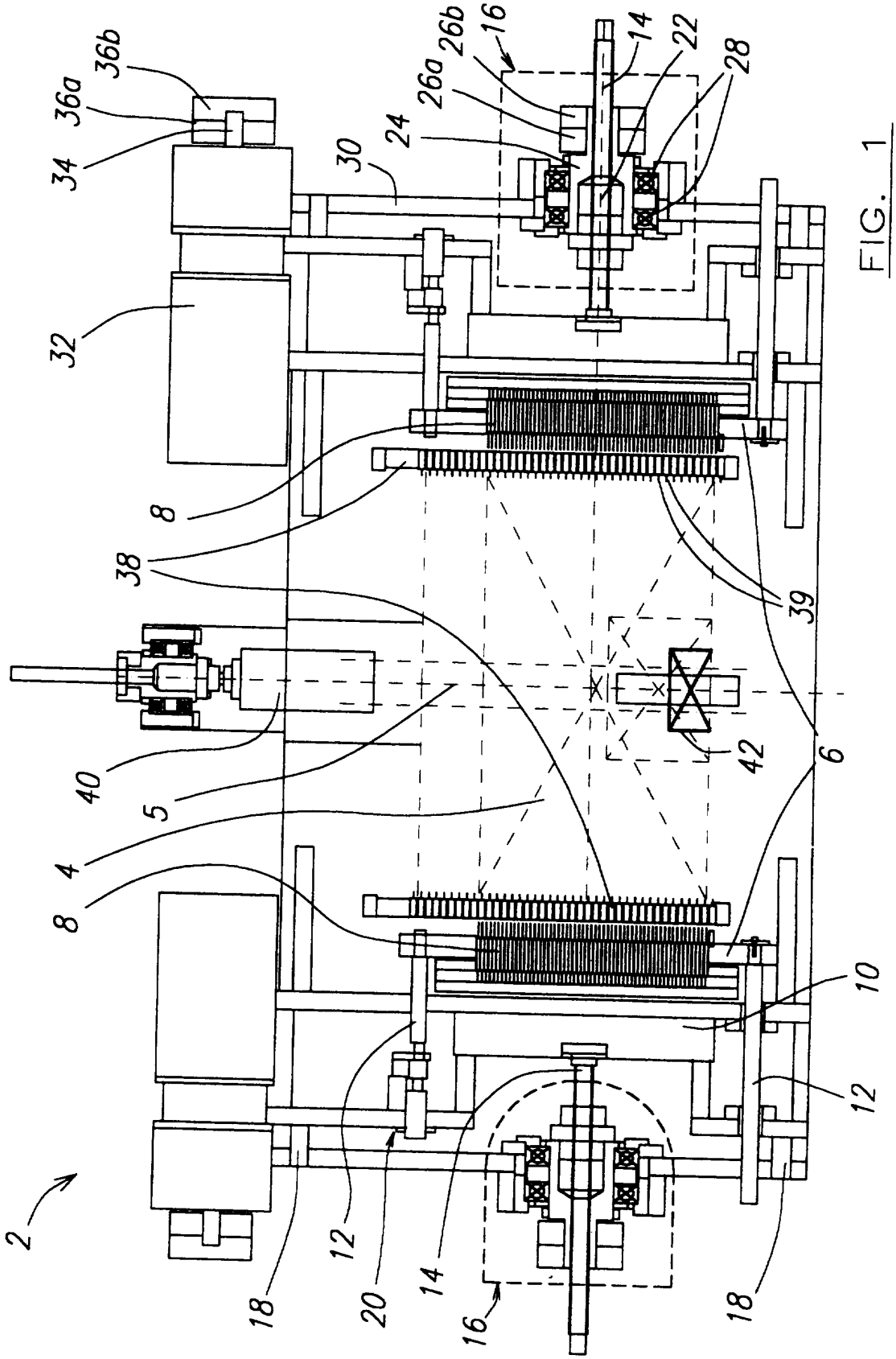
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FIG. 1

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Component Assembly Machine

This invention relates to improvements in component assembly machinery which involves the use of a pressing force, and more particularly to such machinery with pressing plates which are required to translate with a high degree of accuracy and be accurately positioned and remain in such position throughout the pressing action. Such machinery is hereinafter described as pressing machinery.

Although the invention specifically relates to pressing machinery designed for a very great number of pressing operations, the invention may have application to pressing machines in which this is not the case.

The following description of the invention relates to pressing machinery for the construction of heat exchangers of the type which are commonly used in cars, e.g. as radiators, or incorporated into the air conditioning system of the car, or as intercooler for the combustion mixture which fuels the power unit of the car. However, it is to be appreciated that the invention is not limited to such application, and may be incorporated in pressing machinery which is required to operate as described above.

Pressing machinery currently in operation for the construction of car radiators, intercoolers and other heat exchangers is commonly hydraulically operated. In conventional arrangements, the machines comprise a working table of generally rectangular shape surrounded on three sides by pressure plates which are caused to translate by the action of hydraulic fluid pressure on pistons connected to the pressure plates and contained within hydraulic cylinders behind the pressure plates. A pair of the pressing plates translate generally

simultaneously on either side of the component on the working table which is to be assembled. Said component is generally symmetrical.

Components are positioned either automatically or manually on the working table in a desired position thereon in order that the pressure plates apply a pressing action to the correct portions of said components. Heat exchangers for cars are comprised of a number of hollow tubes separated by heat conducting fins. The tubes are generally loaded automatically into the pressing machine from a carriage which translates across the working table of the machine and drops the tubes onto the table. The said tubes, which are usually of oval cross section, are supported in an upright position at their ends and the correct displacement between each tube is maintained by a plurality of horizontal fingers. The fins are then inserted between the tubes manually by the operator of the machine. A pair of side rails is positioned on either side of the tubes and fins, one before the positioning of the tubes and fins, and one after said positioning. This configuration of the tubes, fins, and side rails of the heat exchanger, which is commonly known as the core, is then compressed against a stop on one side of the working table by one of the pressure plates of the machine.

While in the compressed state, headers with apertures to receive the ends of the tubes and side rails are manually slotted over the ends thereof on either side of the core until they abut the ends of the fins between the tubes. At this stage, a pair of pressure plates are caused to translate in a direction transverse to that of the pressure plate which has compressed the core. Said pressure plates are provided with tapered punches which slot within the ends of the hollow tubes, the translating motion of the pressure plates thus expanding the said tube ends and locking the headers in place. The core assembly is thus completed.

Although the side rails prevent a certain amount of expansion of the core once the compression force thereon has been removed, in certain circumstances the core may be additionally strapped between and in a direction parallel to the headers to ensure a good degree of contact between the fins and the tubes in the centre of the heat exchanger, and hence efficient heat transfer therebetween.

It can be appreciated that the translation of the pressure plates parallel to the tubes and fins must be accurately controlled to prevent any force imbalance during the punching and expansion of the tube ends which may result in warping of the core. Likewise, the location of the pressure plates with respect to the ends of the tubes must be such that the tapered punches slide centrally within each of the ends of the tubes to prevent any fouling of said ends during the punching thereof. The completed core is also usually pre-treated with a metallic flux and subsequently brazed in a furnace for further rigidification and to ensure maximum heat transfer across the contact points of the fins and the tubes of the core.

Hydraulic machinery is inherently disadvantaged in that leaks of hydraulic fluid may occur, and in that such machinery is noisy on account of the hydraulic fluid pumps required in its operation, whose power consumption is largely inefficient.

A further disadvantage of hydraulically operated pressing machinery where accuracy of pressing is of paramount importance is that the translation of the pressure plates is actuated by an increase or decrease in hydraulic fluid pressure. Even though the translation of the pressure plates is monitored by transducers or sensors, such methods of translating said pressure plates are often less accurate than mechanical translation methods.

It is an object of this invention to overcome these disadvantages, and furthermore provide a highly precise pressing machine which can nevertheless operate continuously providing high levels of component throughput for long periods of time.

According to the invention there is provided a pressing machine with at least one translating pressure plate wherein the translation of said pressure plate is effected by an electrical motor which drives a roller screw, the pressure plate being drivingly connected thereto.

It is preferable that the pressure plate is connected to the threaded shaft and that the electrical motor drives the roller screw which rotates on the threaded shaft.

It is further preferable that the pressing machine has a pair of opposite pressure plates for working a component therebetween.

Preferably, each of the opposite pressure plates is connected to a separate threaded shaft with roller screw provided thereon which is driven independently of the other.

It is yet further preferable that the electrical driving motors are provided with sensing means to provide a measure of the resultant translation, and therefore the position, of the pressure plates.

It is yet further preferable that the electrical motors are servo-controlled motors.

Preferably the control of the pressing machine is effected by a computer program.

According to a further aspect of the invention, there is provided a machine for assembling elements of a symmetrical component by

pressing the elements together, wherein a pair of press plates are moved together simultaneously and symmetrically towards a datum line which bisects the direction of movement together of the pressers and in relation to which the elements are arranged symmetrically, characterised in that for the accurate assembly by pressing of the elements by the press plates, the pressers are moved by electric servo motors, controlled by press plate position sensing devices, which drive roller feed screws drivingly connected to the press plates.

It is preferable that the motors driving the press plates are provided with sensing means in communication with computing means which control the actuation of said motors wherein the press plates are caused to translate rapidly when not contacting or not proximate the elements to be assembled. Such computer control of the press plates allows for rapid assembly of components on the working table, and represents a significant advance over the preious production rate achievable with hydraulic machinery.

The use of servo-controlled electrical motors greatly reduces the operating noise and power consumption of such pressing machinery, whilst the rotation of roller screws on a threaded shaft provides a mechanical means of translating the pressure plates, which increases the accuracy in the measurement of such translation.

Roller screws have the additional advantage in that such components are both extremely precise and hard wearing, so that many thousands of pressing operations can be completed accurately by the machine before the screws require replacement.

A specific embodiment of the invention is now described by way of example only with reference to the following figure wherein:

Figure 1 shows a simplified plan view of a pressing machine according to the invention.

A pressing machine 2 for the production of heat exchangers for use in cars as hereinbefore described is provided with a working table 4, the datum line of which is indicated at 5, on which the component parts (not shown) of the heat exchanger are located and are acted upon by the pressing machine. A pair of opposite pressure plates 6 are capable of translation in a lateral direction towards and away from each other above the working table 4 and are provided with a plurality of tapered punches 8. The pressure plates 6 are linked to a support member 10 by a pair of slides 12, and a threaded shaft 14 connected to the support member 10 passes through the translation mechanism 16 shown within the dotted lines on the figure. In this embodiment of the invention, the pressing machine is symmetrical, and therefore, in the interests of clarity, relevant parts of the pressing machine 2 have been referenced only once.

The support member 10 is both supported by and allowed to translate on a pair of support slides 18. The length of said support slides is such that the support member 10, and thus the pressure plate 6 are capable of translation from the edge of the working table 4 substantially to the datum line 5 thereof. This extent of travel of the opposite pressure plates 6 allows the pressing machine 2 to be used to work on components of greatly varying sizes.

On one of the slides 12 by which the pressure plate 6 is linked to the support member 10, an adjustment mechanism 20 allows the relative displacement of the support member 10 and the pressure plate 6 to be altered as required.

The translation mechanism 16 comprises a roller screw 22 threaded onto the threaded shaft 14 and mounted in a housing 24 to the end

of which are connected a pair of pulleys 26a, b. The housing 24, and thus the roller screw 22 are allowed to rotate on the threaded shaft 14 by means of bearings 28. The said bearings are mounted between the housing 24 and a fixed member 30 such that rotation of the housing 24 drives the threaded shaft 14 in a desired direction. Thus the translation of the pressure plate is effected.

The rotation of the housing 24 and the roller screw 22 is effected by an electric servo motor, provided internally with transducing or sensor means (not shown), which drives a shaft 34 and a pair of pulleys 36a, b mounted thereon. A pair of timing belts (also not shown) connect the two pairs of pulleys 36a, b and 26a, b in order that the rotation of the shaft 34 of the motor 32 is transmitted effectively and accurately to the housing 24 and roller screw 22. A pair of timing belts is used as a contingency measure in the event of the failure on one of the belts. Once calibrated, the transducing or sensing means of the motor 32 provides a measure of the position of the pressure plate with a high degree of accuracy, as is required in the operation of the pressing machine.

The operation of the machine in the manufacture of heat exchangers is as follows:

On either side of the working table 4, a pair of component rack arms 38 are provided with pegs 39 displaced a distance from each other such that heat exchanger tubes of oval cross section (not shown) may be slotted and thus supported therebetween. Prior to the deposition of such heat exchanger tubes onto the working table, said arms 38 are raised into position and a side rail is placed manually against a stop 42. The heat exchanger tubes are then automatically slotted between said pegs by conventional means. The fins of the heat exchanger (not shown) which take the form of thin sheets of metal folded in a concertina fashion are then manually slotted

between said tubes forming the "core" of the heat exchanger on the working table in an expanded state. After manual location of a further side rail, the core is compressed on the working table 4 by a ram 40 which is translated in a similar manner to the pressure plates as described above but in a transverse direction, against the stop 42.

Once the core is rigidly clamped in position by said ram, the arms 38 may be lowered and header plates slipped over the ends of the tubes and side rails as mentioned hereinabove. The accurate control of the translation of the ram and the accurate positioning of the tubes and fins results in accurate positioning of the tubes of the heat exchanger core with regard to the punches 8 on the pressure plates 6. Lateral translation of said pressure plates moves the punches inside the hollow portions of the tubes and deforms the ends of the tubes such that the headers are locked in place at the ends of the core.

It may be desirable to strap the core to prevent any bowing thereof once the transverse compressive force applied by the ram 40 is removed.

The completed heat exchanger core may be removed from the working table 4 after both the ram 40 and the pressure plates 6 have been withdrawn.

It will be appreciated that the use of servo-controlled electric motors and precise and hard wearing components as described above in a pressing machine of this type allows high rates of production to be achieved. For example, 60 completed heat exchanger cores per hour may be produced on a such a machine.

In a particular embodiment of the invention, the pressure plates 6 and rack arms 38 are interchangeable, and in combination with the

available extent of travel of both the pressure plates 6 and the ram 40, this feature allows a wide variety of components to be worked on the working table 4.

CLAIMS

1. A pressing machine for assembling elements of a component which are essentially similar by pressing the elements together, said machine having at least one translating pressure plate wherein the translation of said pressure plate is effected by an electrical motor which drives a roller screw, the pressure plate being drivingly connected thereto.

2. A pressing machine according to claim 1 wherein the pressure plate is connected to a threaded shaft and that the electrical motor drives the roller screw which rotates on the threaded shaft.

3. A pressing machine according to either of claims 1 or 2 wherein the pressing machine has a pair of opposite pressure plates for working a component therebetween.

4. A pressing machine according to claim 3 wherein each of the opposite pressure plates is connected to a separate threaded shaft with a roller screw provided thereon which is driven independently of the other.

5. A pressing machine according to any of the preceding claims characterised in that the electrical driving motors are provided with sensing means to provide a measure of the translation, and therefore the position, of the pressure plates.

6. A pressing machine according to any of the preceding claims characterised in that the electrical motors are servo-controlled motors.

7. A machine for assembling elements of a symmetrical component by pressing the elements together, wherein a pair of

press plates are moved together simultaneously and symmetrically towards a datum line which bisects the direction of movement together of the pressers and in relation to which the elements are arranged symmetrically, characterised in that for the accurate assembly by pressing of the elements by the press plates, the pressers are moved by electric servo motors, controlled by press plate position sensing devices, which drive roller feed screws drivingly connected to the press plates.

8. A machine according to any of the preceding claims wherein the motors driving the press plates are provided with sensing means in communication with computing means which control the actuation of said motors wherein the press plates are caused to translate rapidly when not contacting or not proximate the elements to be assembled.

The Patent Office

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Application No: GB 9720493.7 **Examiner:** Vaughan Phillips
Claims searched: 1-8 **Date of search:** 15 October 1997

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): B5F

Int Cl (Ed.6): B30B

Other: Online: WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	GB 1473809	(MENGELE) see Fig. 1	1 at least
X	GB 1456169	(ELECTROLUX) see Fig. 1	1 at least
X	GB 1086379	(CHEPOS) see fig. 1	1 at least
X	GB 1009400	(HASENCLEVER) see Fig. 2	1 at least

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.