

The invention relates to a method for reducing the press load of a cutting press, in which the relative position between upper and lower tool is limited by at least one mechanical fixed stop. It relates further to an apparatus for practicing the method according to claim 1, whereby the cutting press includes at least one mechanical stop set into the tool upper part and/or tool lower part and is equipped with a control device having an adjusting motor for altering the ram height during operation.

Specifically in case with high speed cutting presses the ram height must be given special attention. When, for instance, very precise bendings, embossments, a cutting of tear-open covers, etc. are/is necessary, an extreme precise lower dead point position of the ram is needed throughout the operational range of the strokes. When the lower dead point position is imprecise, waste is produced. There is, furthermore, the desire to keep the immersion of the punches of the tool upper part into the tool lower part at a minimal value such that during a respective resharpening of the tool as little as possible must be ground away from the punches and the cutting plate. In case of a large immersion depth more material must be abraded from the punch and the bottom die during a respective resharpening than in case of a small immersion depth. Therefore, the corresponding tool can be resharpened less often until a replacement thereof is necessary.

This means, that the total number of parts produced by means of a respective tool is lower and the corresponding production costs correspondingly higher.

In order to avoid these undesired effects mechanical stops are as a rule provided at the tool lower part and the tool upper part. These mechanical stops keep the relative end position of tool upper part and tool lower part constant throughout the entire stroke range of

a given cutting press. However, the minimal necessary impact forces at a small number of strokes rise considerably together with rising number of strokes and accordingly stress the cutting press additionally.

5 In the DE-A-3 439 459 an apparatus for the automatic correcting of the position of a slide in the press has become known, in which the compression forces are sensed by extension meters at the rods of the press. These forces stem from the impact and immersion of a re-
10 spective tool onto or into, respectively, a workpiece. The forces which propagate to the point of measuring are oscillating which means, that there is a duration of decay. The oscillations decay, however, not before the next oscillations which propagate to the various parts of
15 the machine are produced by the impact such that superpositions arise. Furthermore, the oscillations are damped by the lubricated bearings. The effect of these facts is that the values to be measured occurring at the measuring point are to such an extent imprecise that they
20 cannot be used for a correcting of the position of the slide, because, as known, a preciseness in the range of thousandths of millimeters is necessary.

Here the invention intends to provide a remedy. The invention, such as is characterized in the
25 claims, solves the object to provide a method and an apparatus for practicing same, in which the force is measured which is exerted onto the mechanical stop and the height of the position of the ram is adjusted independently of the measured impact force in such a manner that
30 it remains within a set range.

The advantages gained by the invention are substantially such, that the impact force is measured there where it actually is produced, such that a precise correcting of the height position of the ram can be made.
35 This means an improved quality of the produced article and a smaller wear of a respective tool.

In the following, the invention will be explained more in detail, based on the drawing illustrating one embodiment only.

There is shown in:

5 Fig. 1 schematically a view of a cutting press for the explanation of an embodiment of the invention,

Fig. 2 in part a circuit for the adjusting of the height of the ram,

10 Figs. 3 and 4 diagrams, in which the course of the loading of the press at an increased number of strokes is illustrated, and

Figs. 5 to 7 diagrams, in which the course of the path of the ram in the lower dead point area is illustrated.

15 In the schematic illustration of Fig. 1 the cutting press is identified generally by the reference numeral 1. Furthermore, the ram 2 is drawn, which is linked via pivot bolts 14 to crank arms 16, which in turn are drivingly connected to a not drawn crankshaft, eccentric shaft or other drive. Obviously, these mentioned structural members are to be considered only as an example of the drive of the ram 2.

20 A tool upper part 3 is connected to the ram 2, which tool upper part 3 cooperates with a tool lower part 4, for instance, with cutting plates.

The height position of the ram is adjustable during the operation of the high speed cutting press, for which a schematically illustrated adjusting motor 9 is present, which acts via a driving arrangement 10 onto the ram 2. The position indicator of the adjustment of the height of the ram is indicated by the reference number 11. Cutting punches 8 are set into the tool upper part 3.

35 According to the schematic illustration of Fig. 1 two mechanical stops 5 are arranged in the tool upper part 3. Two mechanical stops 6 are also depicted in the tool lower part 4. It must be noted here, that this

illustration is just exemplary. Basically only one mechanical stop is needed in one of the two tool parts, specifically in the tool lower part 4. It is also possible that more than two mechanical stops are present at a respective tool part or in case of multiple press tools it is possible that only one operating station is equipped with at least one mechanical stop.

These mechanical stops can be, for instance, a block of steel, a steel cyclinder, etc. Because the stroke movement of the tool upper part 3 is limited in the lower dead point range relative to the tool lower part 4 by at least one mechanical stop, definitely no or only the minimally necessary immersion of the tool upper part 3 into the tool lower part 4 following in the corresponding wear occurs, such that the immersion depth amounts to 0 or the desired measure, respectively. This immersion depth can also have negative values such as in case of embossings, i.e. the cutting punch does not reach the bottom die. Quite obviously a corresponding immersion depth can be made possible by a corresponding selection of the height level of the mechanical stops, depending on the prevailing conditions relative to the tools.

When the immersion depth of the ram is too low or gets too low due to the high rotational speeds of the high speed cutting press, a pronounced higher impact force on a respective mechanical stop would be the consequence thereof. Correspondingly at least one mechanical stop is equipped with one or several sensors, in the designed embodiment two mechanical stops 6 equipped with a sensor are located in the tool lower part 4.

Obviously, the impacting of e.g. the tool upper part 3 onto a respective mechanical stop causes the latter to elastically deform in the direction of the stroke of the ram because an impact force is exerted thereupon. Quite obviously this elastic deformation is extremely small, but it can in spite thereof be sensed by a suitable structure. A strain gauge connected in a gen-

erally known manner via a Wheatstone bridge may be arranged at a respective mechanical stop or a piezo-element may be present.

Reference is now made to Fig. 2. In this figure the ram 2, a mechanical stop 5 in the tool upper part 3 and a mechanical stop 6 in the tool lower part 4 are illustrated. A few cutting punches 8 are, furthermore, illustrated, too.

The mechanical stop 6 is now equipped with one structure 15 as described above, which depending on the respective impact force registers the elastic deformation of the mechanical stop 6 and emits an electric signal.

This signal is led to a signal amplifier 12 and the output of this signal amplifier 12 is led to a control unit 13 for the adjusting of the height of the punch. This control unit 13 is connected to the adjusting motor 9 for the adjusting of the height of the punch and with the position indicator 11 of the ram height adjusting unit. The adjusting motor 9 drives the transmission set 10 for the adjusting of the height of the ram. The structures 9-11 and 13 are of a well-known design, such as also is the case of the signal amplifier 12 and accordingly, a detailed description of these structures is not needed.

The operation of the above described embodiment is as follows. It shall be assumed, that in operation of the cutting press an impacting on a mechanical stop occurs at each stroke. As already mentioned, the tiny elastic deformation of the mechanical stop occurring thereby is transformed into an electrical signal. Now, obviously a precisely determinable impact force and corresponding electric signal correspond to a proper operation of a design level of the ram. It is thereby not necessary, to set one single value but rather a value range or a value with tolerance limits, respectively.

If now the height position of the ram is too large, such that no or a too weak impacting on the mechanical stop occurs, waste could be produced because a corresponding part of the tool, e.g. a ram, does not
5 penetrate during an embossing far enough into a workpiece or in case of cutting, does not penetrate completely through the workpiece.

The corresponding signal is below a set limit, which state is determined in the control section
10 13, and which transmits correspondingly a signal to the adjusting motor 9 for the adjusting of the height of the ram, which signal causes a changing of the height of the ram until an impacting force occurs, which has been set for a proper operation.

15 If a too large impacting force in comparison with a set value or range of values, respectively, is determined, it is the indication of a too low position of the ram, which leads to an undesired additional loading of the press. Correspondingly, the servomotor 9 is con-
20 trolled in such a manner that the height position of the ram is increased until again a set impact force prevails and the press is accordingly relieved.

This controlling of the height of the ram is used specifically in case of different rotational speeds
25 or number of strokes, respectively, at high speed cutting presses, e.g. during the start-up or by changing the number of strokes during normal operation.

It is generally known, that in case of not controlled cutting presses the immersion depth of an up-
30 per tool into a corresponding lower tool increases upon an increasing speed of operation, i.e. a higher number of strokes. The present design guarantees by the mechanical stops that the immersion depth is absolutely limited or, if needed, even 0. The height position of the ram can now
35 be controlled during the operation depending on the prevailing conditions, whereby the basis of the control is not based on a measurement e.g. of the rotational speed,

but rather on the actually occurring impact force. The impact force is thereby detected directly on the part subject to same, namely at the mechanical stop, whereby an elastic deformation is scanned. Thus, no measuring is
 5 made at a point remote from the impacting on the mechanical stop, which measuring will be rendered imprecise by deformations of parts of the machine, of changes in bearings in operation. Accordingly, the loading of the mechanical stops, i.e. the impact force occurring
 10 thereupon, can be held constant at changing number of strokes. In the control part 13 a selectable base correction value can be set when starting up a newly assembled machine regarding height of the punch depending on the number of strokes, and after the coupling in, one
 15 can switch over to a controlling depending on a set impact force corresponding to the values supplied by the sensor or sensors, respectively. It is also possible to set in the control part 13 the adjustment of the height of the punch which depends from the number of strokes,
 20 whereby the values supplied from the sensors can correct the previously set values in an overriding manner. The controlling of the height position of the punch occurs also when temperature conditions change, e.g. during a start-up of a cold press and also when the environmental
 25 temperature changes.

Reference is made now to Figs. 3 and 4. The rotational speed (number of strokes) of a respective cutting press is identified by "n" and the loading of the press generally by "F". Basically, a cutting press is de-
 30 signed for a nominal pressing force F_N . This design determines, accordingly, the size of the machine and accordingly decisively the purchase price for the user of a respective machine. The cutting force or embossing force, respectively, is identified by F_{St} . This is the force oc-
 35 ccurring in the tool which must be provided by the cutting press for a respective operation, e.g. in punching, embossing, bending, etc., corresponding to the product to

be produced. The impact force on the mechanical stop or mechanical stops, respectively, which also is to be provided by the cutting press, is identified by F_A . The sum $F_{St} + F_A$ determines accordingly the force which must be provided by the cutting press (notwithstanding the inner losses of the machine occurring e.g. by bearing frictions), determines accordingly the design or size, respectively, and finally the costs of same.

In Fig. 3, an initial number of strokes n_1 shall be e.g. 100 strokes per minute. The loading F of the press is, therefore, the sum $F_{St} + F_A$. It shall here now be assumed, that a tool including mechanical stops is installed. Furthermore it shall be assumed, that the height of the ram remains unchanged, i.e. that no measures for an adjusting of the height of the ram (e.g. depending on the number of strokes or from the impact force) are made, such that the force which must be produced by the cutting press increases at an increasing number of strokes. The force F of the press increases at a rising n corresponding to the curve drawn as continuous line. The number of strokes n_2 , for instance 1000 strokes per minute, is assumed to be the maximal number of strokes of this cutting press. At n_2 the design press force F_N of this cutting press is set, thus the value determining the design and finally the costs of the press.

The curve indicated by broken lines indicates now the press force F which must be produced by the cutting press equipped in accordance with the invention with an adjusting of the height of the ram. It is now specifically to be noted, that the impact force onto the mechanical stop or the mechanical stops, respectively, will now be held constant over the total range of stroke numbers due to the adjusting of the height of the ram being made. The broken curved line extends below the full line again up to the maximal number of strokes n_2 . Accordingly, a decisive reduction of the press force which must be produced by the press is obtained, which

reduction is identified by F_R . At a same size of the cutting press a reduction of the loading thereof is arrived at, which amounts to 20 to 30%! Conclusively, this means that in the case of mechanical stops combined with an adjustment of the height of the ram the corresponding cutting press to be purchased must not be designed for the same working force F_N , but rather only for $F_N - F_R$. Accordingly, a "small" machine is needed which leads to decisive savings on costs when purchasing same.

Attention is now drawn to Fig. 4, in which the lettering corresponds to that of Fig. 3. The diagram is based on a cutting press which is identical to the one of Fig. 3 with the designed pressing force F_N , accordingly in which the loading of the press without an adjusting of the height of the ram at an increasing number of strokes increases along the solid curve line (of Fig. 3).

At the press forming the basis of the diagram of Fig. 4 the adjusting of the height of the ram and also the limiting of the stroke by means of mechanical stops are present. The value F_A , thus the impact force onto a respective mechanical stop at the number of strokes n_1 is the same as the one at Fig. 3 and is kept constant at a rising number of strokes. Because, however, the loading of the press at an increasing number of strokes up to n_2 can again rise up to the same value F_N according to the design press force, F_{St} can now be correspondingly and decisively larger. This means, that at a given cutting press which is equipped with mechanical stops and an adjusting of the height of the ram the working force which is available is distinctly larger. The difference can amount up to 40%. And this leads obviously to considerable savings when purchasing a cutting press because on the correspondingly equipped cutting press a much higher operating force for the working of workpieces is available.

Reference is now made to Figs. 5-7. These figures illustrate schematically the course of the ram in its lower dead point range. The letter t denotes the course of time and h the path of the ram.

5 Fig. 5 illustrates the course of the ram at a low number of strokes, for instance, when setting up the cutting press. If no mechanical stops are present, the lowermost position of the ram corresponds to the position B, whereby the specific course of the ram without a
10 mechanical stop and without performing a cutting or embossing work is illustrated by a broken line. If mechanical stops are present, the course of the ram (including the cutting or embossing, respectively, work) follows the solid line curve, whereby now the lowermost
15 position of the ram is at A. Specifically to be noted is that due to the mechanical stop the course of the ram at the lowermost position of the ram is designed as rectilinear path. No further downwards movement occurs. Thus, an exactly defined lowermost relative position relative
20 to the lower tool part is present due to the mechanical stops.

 Fig. 6 illustrates the course of the ram in the range of the lower dead point during operation. Without mechanical stops, without the controlling or correct-
25 ing, respectively, of the height of the ram and without any cutting or embossing, respectively, work the course of the ram extends in accordance with the curve designed with a broken line in order to reach the lowermost position of the ram according to the position of the letter
30 B.

 With mechanical stops and a cutting or embossing, respectively, operation the course of the ram extends along the solid line, whereby the lowermost position of the ram is present at A. Attention is drawn to
35 the relatively long horizontal path, i.e. relatively long time span, during which accordingly the impacting force acts onto the mechanical stop. The large difference

Δh from A to B indicates a high impacting force onto the mechanical stops.

Fig. 7 illustrates the same operational condition of the cutting press as in Fig. 6. The course of the ram at mechanical stops and with a controlling of the height of the ram which is controlled in dependency on the impact force proceeds along the solid line of Fig. 7. The lowermost position of the ram is again identified by A. The duration of time of this lowermost position of the ram according to the horizontally extending line at A is now considerably shorter than in case of the course of the ram according to Fig. 6. The broken line, which illustrates the lowermost position B, represents same without mechanical stops but with a controlling of the height of the ram.

The small difference $\Delta h'$ from A to B confirms the low impact pressure onto the mechanical stops.

The sensor(s) could (can) form also a structural unit separate from the corresponding mechanical stop and be thereby installed adjacent or directly under the mechanical stop. The mechanical stop can also be designed in form of a frame.

Patent Claims

5 1. Method for reducing the pressing load of a
cutting press, in which a relative position between upper
and lower tool is limited by at least one mechanical pos-
itive stop, characterized in that the impact force ex-
erted on the respective mechanical positive stop (5; 6)
10 is measured, and in that the height position of the ram
(2) is adjusted, depending on the impact force measured
such that the latter remains within a fixed range.

 2. Method according to claim 1, characterized
in that the impact force is measured by sensing the de-
15 formation of the mechanical positive stop (5; 6) result-
ing therefrom.

 3. Method according to claim 2, characterized
in that the deformation sensed is of an elastic nature
and is transformed into an electrical signal, which is
20 amplified and then supplied to a control device (13) for
controlling a drive (9, 10) for height adjustment of the
ram (2).

 4. Method according to claim 1, characterized
in that the limiting of the working stroke, measuring of
25 the impact force and adjusting of the height position of
the ram (2) is effected during working operation of the
cutting press.

 5. Apparatus for implementing the method ac-
cording to claim 1, whereby the cutting press has at
30 least one mechanical positive stop (5; 6) inserted into
the tool upper part (3) and/or tool lower part (4) and is
equipped with a control device (9 - 11) containing an
adjusting motor (9) for altering the height of the ram
during operation, characterized in that one or more
35 devices (15) for sensing the impact force on the
mechanical positive stop (5; 6) are allocated to same,

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the output signal of which is supplied to a control device (9 - 11) for adjusting the ram height.

6. Apparatus according to claim 5, characterized in that a plurality of mechanical positive stops (5; 6) are present in the tool upper part (3) and/or tool lower part (4), of which at least one has a device (15) for sensing the impact force.

7. Apparatus according to claim 6, characterized in that the respective device (15) for sensing the impact force has a component, by means of which a deformation of the mechanical positive stop (5; 6) can be determined and this measured value can be converted into an electrical signal.

8. Apparatus according to claim 7, characterized in that the component is designed for the determination of an elastic deformation of the respective mechanical positive stop (5; 6) occurring in the direction of the ram stroke.

9. Apparatus according to claim 8, characterized in that the component includes a strain gauge or a piezoelectric element mounted to the respective fixed stop.

10. Apparatus according to claim 5, characterized in that the device for sensing the impact force exerted on the mechanical positive stop is designed separately from the mechanical positive stop.

