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Spring-damper element for the mounting of a punching press

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TECHNICAL FIELD

The invention relates to a spring-damper element for the mounting of a punching press, the use of the spring-damper element for the mounting of a punching press, as well as methods for operating punching presses which are mounted on such spring-damper elements, according to the preambles of the independent patent claims.

STATE OF THE ART

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Large punching presses with more than 200 kN nominal load are equipped with mass balancing and spring-damper elements. They do not require special foundations and do also not have to be fixed to the ground. The machine and the spring-damper elements together form a single-mass oscillator with a relatively low resonance frequency of e.g. 2.5 Hz or 150 min⁻¹, respectively.

The spring-damper elements thereby fulfil several functions. On the one hand, they serve to reduce the ground loading from dynamic mass forces, to prevent the machine from "building up vibrations" in the resonance range, and to reduce the machine movement when the press is coupled in and out. On the other hand, they serve to guide the punching press in the horizontal plane.

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When designing the mass compensation of the presses, an average weight for the upper tool part is taken into account, from which the actual tool weight often deviates significantly.

Accordingly, different punching jobs can result in different operating conditions with regard to the vibration excitation of the system due to different

5 imbalance masses and punching frequencies, which makes it
hardly possible to design the spring-damper elements for
a variable operation.

When designing the spring-damper elements for
an operation at high punching frequencies, the problem
10 typically arises that very large amplitudes result in the
operation at low punching frequencies, which can
significantly impair the range of application of the
press.

When designing the spring-damper elements for
15 an operation at low punching frequencies close to the
resonance frequency, the problem arises that
unnecessarily high ground loadings typically occur in the
operation with relatively high punching frequencies. In
general, in this design, also the problem arises that the
20 impact forces from the punching impact are transmitted to
the ground via the spring-damper elements, which then
leads to a very high short-term ground loading.

From EP 0 270 762 A1 there are known generic
spring-damper elements, in which the latter problem is
25 tackled by a pressure relief valve in the damper piston,
which limits the supporting pressure of the spring-damper
element and thus the maximum ground loading.

DISCLOSURE OF THE INVENTION

30 The objective arises to provide technical
solutions which do not exhibit the aforementioned
disadvantages of the state of the art or which at least
partially avoid them.

This objective is solved by the subject-
35 matter of the independent patent claims.

According to these, a first aspect of the
invention relates to a spring-damper element for the
mounting of a punching press.

The spring-damper element comprises a
40 hydraulic damper unit. This comprises a first fluid
chamber and a second fluid chamber, wherein during the

5 intended operation a hydraulic fluid is displaced from
the first fluid chamber via a throttle point into the
second fluid chamber when the spring-damper element is
compressed, and thus a damping effect is achieved. An
overload valve is arranged between the first fluid
10 chamber and the second fluid chamber of the damper
element, which overload valve opens when a specific fluid
pressure is reached in the first fluid chamber or when a
specific pressure difference is reached between the first
fluid chamber and the second fluid chamber and releases a
15 bypass via which hydraulic fluid then flows from the
first fluid chamber into the second fluid chamber,
bypassing the throttle point, thereby substantially
preventing a further increase in pressure in the first
fluid chamber. The fluid pressure or the pressure
20 difference, respectively, at which the overload valve
opens can be adjusted in steps or steplessly when the
spring-damper element is installed as intended, in
particular manually, particularly without tools, and/or
automatically by means of a control system with
25 externally actuated adjustment means, such e.g. as
actuators or pneumatic cylinders.

With the spring-damper elements according to
the invention it becomes possible to create a mounting
arrangement for a punching press, the damping
30 characteristics of which can be adjusted without
significant effort, such that a variable operation of the
press in wide ranges becomes possible while keeping the
ground loading to a minimum in each case.

In an advantageous embodiment of the spring-
35 damper element, its hydraulic damper unit is designed in
such a way that, in the intended operation, during
rebound of the spring-damper element, hydraulic fluid
flows back from the second fluid chamber into the first
fluid chamber via a flow cross-section which is wider
40 than the throttle cross-section. The damper unit
therefore works essentially in the direction of

5 compression in this embodiment and has no or a
significantly lower damping effect in the direction of
rebound than in the direction of compression. This makes
it possible to dispense with a fastening the spring-
damper elements on the ground.

10 Preferably, the hydraulic damper unit of the
spring-damper element is designed in such a way that the
fluid pressure or pressure difference, respectively, at
which the overload valve opens is adjustable during
intended operation. This makes it possible to set the
15 optimum damping for the respective operating state during
operation, in particular by means of a control system
which determines the parameters of the vibration
movement, such as amplitudes and accelerations, and
adjusts the damping of the spring-damper elements until a
20 desired parameter constellation is reached.

In another preferred embodiment of the
spring-damper element, its hydraulic damper unit is
designed in such a way that the fluid pressure or the
pressure difference, respectively, at which the overload
25 valve opens can be set practically to zero, such that
when the spring-damper element is compressed, the
overload valve opens without any noteworthy pressure
build-up in the first fluid chamber, as a result of which
the hydraulic damper unit is practically ineffective at
30 least in the direction of compression.

Alternatively, the hydraulic damper unit is
designed in such a way that the overload valve can be
brought into an open state such that the hydraulic fluid
can flow back and forth between the first and second
35 fluid chambers in a practically unhindered manner when
the spring-damper element is compressed or rebound, as a
result of which the hydraulic damper unit is practically
ineffective in both the compression and the rebound -
direction.

40 In yet another preferred embodiment of the
spring-damper element, its hydraulic damper unit

5 comprises a switchable bypass valve between the first
fluid chamber and the second fluid chamber, which
releases a bypass in the open state, via which hydraulic
fluid flows from the first fluid chamber into the second
fluid chamber while bypassing the throttle point when the
10 spring-damper element is compressed, and via which
hydraulic fluid flows from the second fluid chamber into
the first fluid chamber when the spring-damper element is
rebound, such that the hydraulic damper unit is
practically ineffective in both the compression and the
15 rebound direction.

With the aforementioned preferred embodiments
of the spring-damper element, the damper unit can be made
practically ineffective for an operation with relatively
high punching frequencies, such that the ground loadings
20 are minimized.

With an advantage, the spring-damper element
comprises a pneumatic cylinder for setting the fluid
pressure or the pressure difference, respectively, at
which the overload valve opens, which pneumatic cylinder,
25 during intended operation, is pressurized with a specific
air pressure and therefore generates a specific valve
closing force. Thereby, a sensitive and easy to automate
setting can be realized in a simple manner.

Alternatively or in addition, it is preferred
30 that the spring-damper element for setting the fluid
pressure or the pressure difference, respectively, at
which the overload valve opens comprises a threaded
spindle which acts on one or more valve springs and
thereby generates a certain valve closing force. Thereby,
35 a manual adjustment can be realized in a particularly
simple and reliable manner.

A second aspect of the invention relates to
the use of the spring-damper element according to the
first aspect of the invention for mounting a punching
40 press. In such uses, the advantages of the invention are
particularly obvious.

5 A third aspect of the invention relates to a
method for operating a punching press mounted on spring-
damper elements according to the first aspect of the
invention. Thereby, at different intended operating
conditions, the punching press is respectively operated
10 with different settings of the fluid pressure or pressure
difference, respectively, at which the overload valves of
the spring-damper elements open.

 A fourth aspect of the invention relates to
another method for operating a punching press which is
15 mounted on spring-damper elements according to the first
aspect of the invention. Thereby, the setting of the
fluid pressure or the pressure difference, respectively,
at which the overload valves of the spring-damper
elements open is adjusted during the intended operation
20 of the punching press to change the amplitude with which
the punching press oscillates in the spring-damper
elements.

 With the inventive methods according to the
third and fourth aspect of the invention, which are
25 advantageously combined, it becomes possible to adapt the
damping characteristics of the mounting of the punching
press to the respective operating condition, such that a
variable operation of the press in wide ranges becomes
possible at minimum ground loading in each case.

30 Thereby, it is further preferred that the
adjustment of the fluid pressure or the pressure
difference, respectively, at which the overload valves of
the spring-damper elements open is changed in such a way
that the punching press oscillates with a certain
35 amplitude in the spring-damper elements, preferably with
a maximum permissible amplitude. This makes it possible
to keep ground loadings as low as possible, especially
when operating at low punching frequencies close to the
resonance frequency.

40 Preferably, thereby, the amplitude is
measured, e.g. by means of one or more distance measuring

5 sensors, and the adjustment of the fluid pressure or the
pressure difference, respectively, at which the overload
valves of the spring-damper elements open, is
automatically controlled by a machine controller in such
a way that the punching press oscillates with a desired
10 amplitude in the spring-damper elements.

If the amplitude is measured separately for
each spring-damper element and the setting of the fluid
pressure or the pressure difference, respectively, at
which its overload valve opens is controlled, the
15 oscillation behavior of the punching press can be further
optimized, e.g. pitching movements due to uneven load
distribution can be compensated for.

The adjustment of the fluid pressure or the
pressure difference, respectively, at which the overload
20 valves of the spring-damper elements open, is preferably
effected with the aid of pneumatic cylinders, which are
subjected to a certain air pressure and generate a
corresponding valve closing force. Thereby, a sensitive
and easy to automate setting can be realized in a simple
25 manner.

Alternatively or in addition, it is preferred
to adjust the fluid pressure or the pressure difference,
respectively, at which the overload valves of the spring-
damper elements open with the aid of threaded spindles
30 which act on one or more valve springs and thereby
generate a valve closing force. Thereby, a manual
adjustment can be realized in a particularly simple and
reliable manner.

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BRIEF DESCRIPTION OF THE DRAWINGS

Further embodiments, advantages and
applications of the invention result from the dependent
claims and from the now following description on the
40 basis of the figures. Thereby show:

5 Fig. 1 a punching press which is mounted on
spring-damper elements according to the invention;

 Fig. 2 a vertical section through one of the
spring-damper elements from Fig. 1;

 Fig. 3 a vertical section through a first variant
10 of the spring-damper element from Fig. 2; and

 Fig. 4 a vertical section through a second
variant of the spring-damper element from Fig. 2.

MODES FOR CARRYING OUT THE INVENTION

15 Fig. 1 shows a punching press 1 which is
mounted on four identical spring-damper elements 2
according to the invention on a factory floor 21.

 As can be seen in synopsis with Fig. 2 which
shows a vertical section through one of the spring-damper
20 elements 2, the spring-damper element 2 comprises a
central hydraulic damper unit 3 which is surrounded by
six helical spring packages 15 arranged with uniform
pitch on a concentric circle around it, over which a
support plate 16 which supports a support column 17 of
25 the punching press 1, is supported on a support body 18,
which comprises the hydraulic damper unit 3 and is
supported on the floor 21 over a floorplate 19 and a
damping mat 20 arranged underneath it. Each of the
helical spring packages 15 comprises a smaller coil
30 spring 15a and a larger coil spring 15b, whereby the
smaller coil spring 15a is arranged concentrically within
the larger coil spring 15b.

 The hydraulic damper unit 3 comprises a first
fluid chamber 4 and a second fluid chamber 5 which are
35 filled with a hydraulic fluid and are separated from each
other by a damper piston 23 which is connected to the
support plate 16 via a ball pin 24.

 In the damper piston 23, a connection channel
22 is arranged which extends between the first fluid
40 chamber 4 and the second fluid chamber 5 and in which a
throttle point 6 is arranged. The throttle point 6 is

5 formed by a type of check valve, the valve closing body
of which is formed by a plate 25 with a throttle bore.
When pressure is applied to this check valve on its side
facing the first fluid chamber 4, the plate 25 is pressed
against a valve seat such that the first fluid chamber 4
10 and the second fluid chamber 5 are only connected to each
other via the throttle bore in the plate 25. When this
check valve is pressurized on its side facing the second
fluid chamber 5, the plate 25 is pushed away from the
valve seat and releases a flow cross-section which is
15 significantly larger than its throttle bore, via which
the first fluid chamber 4 and the second fluid chamber 5
are then connected to each other.

Accordingly, during compression of the
spring-damper element 2, which results in a displacement
20 of the damper piston 23 into the first fluid chamber 4
and subsequently in a pressure increase in the first
fluid chamber 4, hydraulic fluid is displaced from the
first fluid chamber 4 into the second fluid chamber 5
only via the throttle bore in the plate 25, with the
25 effect that a damping effect is achieved during
compression.

During rebound, on the other hand, a
considerably larger flow cross-section is available for
the return flow of hydraulic fluid from the second fluid
30 chamber 5 into the first fluid chamber 4, and this
results in a significantly lower damping effect or no
damping effect at all.

As can be seen further on, the hydraulic
damper unit 3 further comprises an easily accessible
35 overload valve 7 arranged on the outside of the spring-
damper element 2, which is associated with a bypass-line
8 between the first fluid chamber 4 and the second fluid
chamber 5 and which opens when a specific fluid pressure
is reached in the first fluid chamber 4 or when a
40 specific pressure difference is reached between the first
fluid chamber 4 and the second fluid chamber 5, such that

5 hydraulic fluid then flows from the first fluid chamber 4 via the bypass line 8 into the second fluid chamber 5, bypassing the throttle point 6. Thereby, a further increase in pressure in the first fluid chamber 4 is prevented.

10 This overload valve 7 essentially consists of a valve plate 26 which is pressed against a valve seat by a spring 13. The spring preload can be adjusted with a threaded spindle 12 or it can be revoked completely. At the top of the threaded spindle 12, a marking edge 27 is
15 arranged directly opposite a scale 28, by means of which the set spring preload can be metered.

Fig. 3 shows a vertical section through a first variant of the spring-damper element, which differs from the spring-damper element shown in Fig. 2 only in
20 that the valve plate 26 of the overload valve 7 is not loaded by a spring pretensioned by means of a threaded spindle, but by means of a pneumatic cylinder 11 which is pressurized with a specific air pressure in accordance with the desired opening pressure. This spring-damper
25 element also has a distance measuring sensor 14, by means of which the oscillating movement of the punching press is detected by a machine controller (not shown) and the compressed air supply to the pneumatic cylinder 11 is automatically regulated in such a way that the punching
30 press 1 oscillates with a desired amplitude in the spring-damper elements 2.

Fig. 4 shows a vertical section through a first variant of the spring-damper element, which differs from the spring-damper element shown in Fig. 2 only in
35 that the hydraulic damper unit 3 additionally comprises a switchable bypass valve 9 arranged between the first fluid chamber 4 and the second fluid chamber 5, which bypass valve 9 in the open state releases a bypass 10, via which hydraulic fluid flows from the first fluid
40 chamber 4 into the second fluid chamber 5 when the spring-damper element 2 is compressed bypassing the

5 throttle point 6 and the overload valve 7, and hydraulic
fluid flows back from the second fluid chamber 5 into the
first fluid chamber 4 when the spring-damper element 2 is
rebound, in such a way that practically no damping effect
is present in both directions.

10 While in the present application preferred
embodiments of the invention are described, it must be
clearly pointed out that the invention is not limited to
these and that it can also be realized in another way
within the scope of the now following patent claims.

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PATENT CLAIMS

1. Spring-damper element (2) for the mounting of a punching press (1), with a hydraulic damper unit (3) with a first fluid chamber (4) and a second fluid chamber (5), wherein, in the intended operation, a hydraulic fluid is displaced from the first fluid chamber (4) via a throttle point (6) into the second fluid chamber (5) during compression of the spring-damper element (2), and with an overload valve (7) arranged between the first fluid chamber (4) and the second fluid chamber (5), which, on reaching a specific fluid pressure in the first fluid chamber (4) or on reaching a specific pressure difference between the first fluid chamber (4) and the second fluid chamber (5), opens and releases a bypass (8), via which hydraulic fluid then flows from the first fluid chamber (4) into the second fluid chamber (5), bypassing the throttle point (6), wherein the spring-damper element (2) is designed in such a way that the fluid pressure or the pressure difference, respectively, at which the overload valve (7) opens is adjustable when the spring-damper element (2) is installed as intended.

2. Spring-damper element (2) according to claim 1, wherein the hydraulic damper unit (3) is designed in such a way that, in the intended operation, during rebound of the spring-damper element (2), hydraulic fluid flows back from the second fluid chamber (5) into the first fluid chamber (4) via a flow cross-section which is wider than the cross-section of the throttle point (6).

3. Spring-damper element (2) according to one of the preceding claims, wherein the fluid pressure or the pressure difference, respectively, at which the overload valve (7) opens is adjustable steplessly or in steps, in particular without tools.

5 4. Spring-damper element (2) according to one
of the preceding claims, wherein the fluid pressure or
the pressure difference, respectively, at which the
overload valve (7) opens is manually adjustable and/or
automatically adjustable via a control system.

10 5. Spring-damper element (2) according to one
of the preceding claims, wherein the fluid pressure or
the pressure difference, respectively, at which the
overload valve (7) opens is adjustable during the
15 intended operation.

 6. Spring-damper element (2) according to one
of the preceding claims, wherein the fluid pressure or
the pressure difference, respectively, at which the
20 overload valve (7) opens is adjustable to substantially
zero or the overload valve (7) can be brought into an
open state.

 7. Spring-damper element (2) according to one
25 of the preceding claims, wherein the hydraulic damper
unit (3) comprises a switchable bypass valve (9) arranged
between the first fluid chamber (4) and the second fluid
chamber (5), which in the open state releases a bypass
(10), via which hydraulic fluid flows from the first
30 fluid chamber (4) into the second fluid chamber (5)
during compression of the spring-damper element (2),
bypassing the throttle point (6), and via which hydraulic
fluid flows from the second fluid chamber (5) into the
first fluid chamber (4) during rebound of the spring-
35 damper element (2).

 8. Spring-damper element (2) according to one
of the preceding claims, wherein the spring-damper
element (2) comprises a pneumatic cylinder (11) for
40 adjusting the fluid pressure or the pressure difference,
respectively, at which the overload valve (7) opens,

5 which pneumatic cylinder (11) is subjected to a specific
air pressure during the intended operation.

9. Spring-damper element (2) according to one
of the preceding claims, wherein the spring-damper
10 element (2) comprises a threaded spindle (12) which acts
on one or more valve springs (13) for adjusting the fluid
pressure or the pressure difference, respectively, at
which the overload valve (7) opens.

15 10. Use of the spring-damper element (2)
according to one of the preceding claims for mounting of
a punching press (1).

11. Method for operating a punching press (1)
20 which is mounted on spring-damper elements (2) according
to one of the claims 1 to 9, wherein the press (1) is
operated with different settings of the fluid pressure or
the pressure difference, respectively, at which the
overload valves (7) of the spring-damper elements (2)
25 open, during different intended operating conditions.

12. Method for operating a punching press (1)
which is mounted on spring-damper elements (2) according
to one of the claims 1 to 9, in particular according to
30 claim 11, wherein the setting of the fluid pressure or
the pressure difference, respectively, at which the
overload valves (7) of the spring-damper elements (2)
open, is changed during the intended operation of the
punching press (1) for changing the amplitude with which
35 the punching press (1) oscillates in the spring-damper
elements (2).

13. Method according to claim 12, wherein the
setting of the fluid pressure or the pressure difference,
40 respectively, at which the overload valves (7) of the
spring-damper elements (2) open, is changed in such a way

5 that the punching press (1) oscillates with a certain
amplitude in the spring-damper elements (2), in
particular with a maximum permissible amplitude.

14. Method according to claim 13, wherein the
10 amplitude is measured, in particular by means of one or
more distance measuring sensors (14), and the adjustment
of the fluid pressure or the pressure difference,
respectively, at which the overload valves (7) of the
spring-damper elements (2) open, is automatically
15 regulated by means of a machine controller in such a way
that the punching press (1) oscillates with a desired
amplitude in the spring-damper elements (2).

15. Method according to claim 14, wherein the
20 amplitude is measured separately for each spring-damper
element (2) and the adjustment of the fluid pressure or
the pressure difference, respectively, at which its
overload valve (7) opens, is controlled.

16. Method according to one of the claims 11
25 to 15, wherein the adjustment of the fluid pressure or
the pressure difference, respectively, at which the
overload valves (7) of the spring-damper elements (2)
open, is effected by means of pneumatic cylinders (11)
30 which are subjected to a specific air pressure.

17. Method according to one of the claims 11
to 15, wherein the adjustment of the fluid pressure or
the pressure difference, respectively, at which the
35 overload valves (7) of the spring-damper elements (2)
open, is effected by means of threaded spindles (12)
which act on one or more valve springs (13).