

July 31, 1956

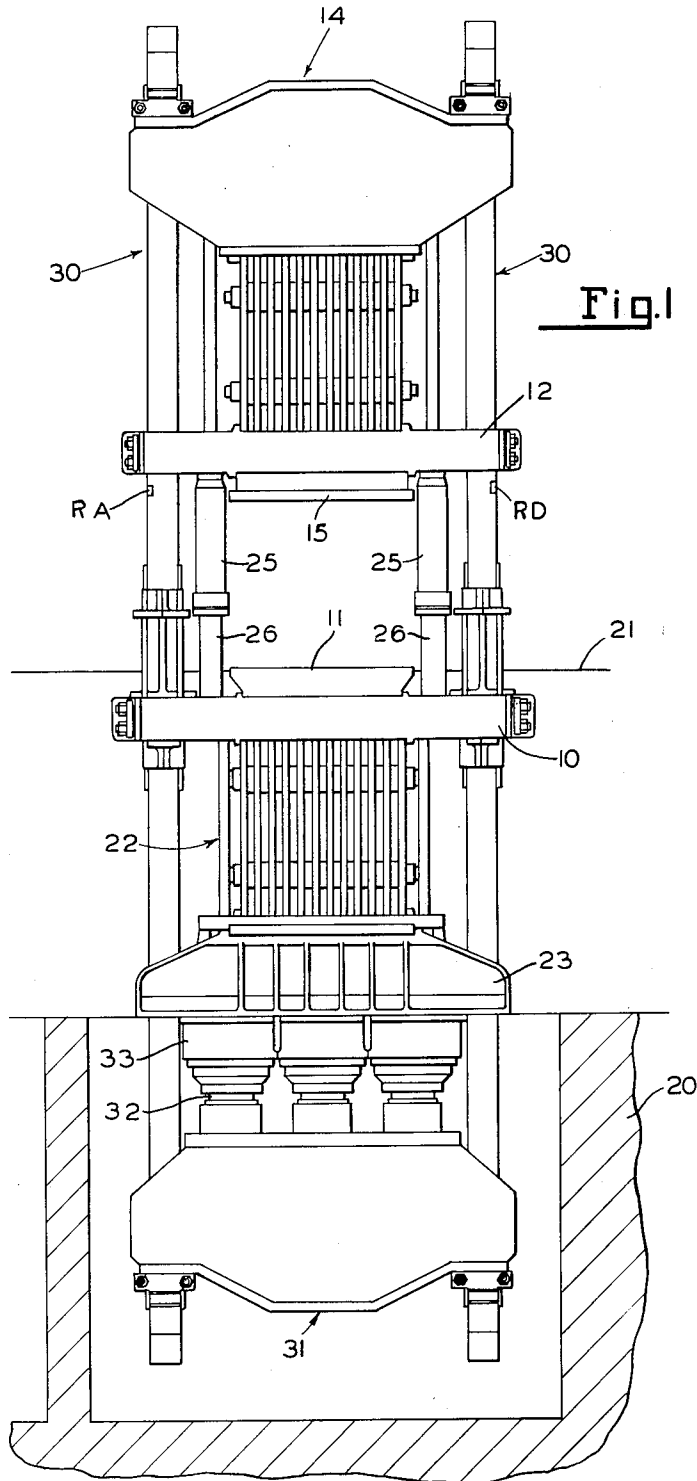
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MEANS FOR INDICATING LOAD ECCENTRICITY IN PRESSES

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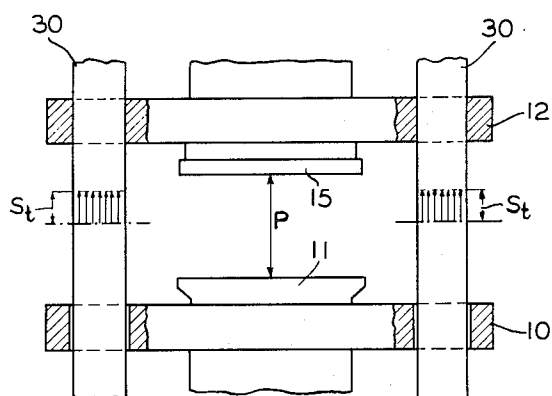


Fig. 2A

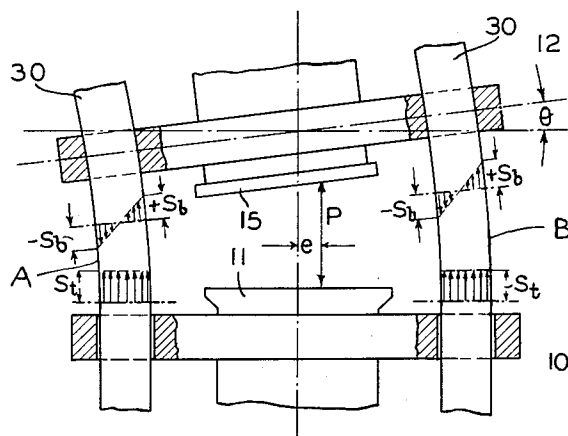


Fig. 2B

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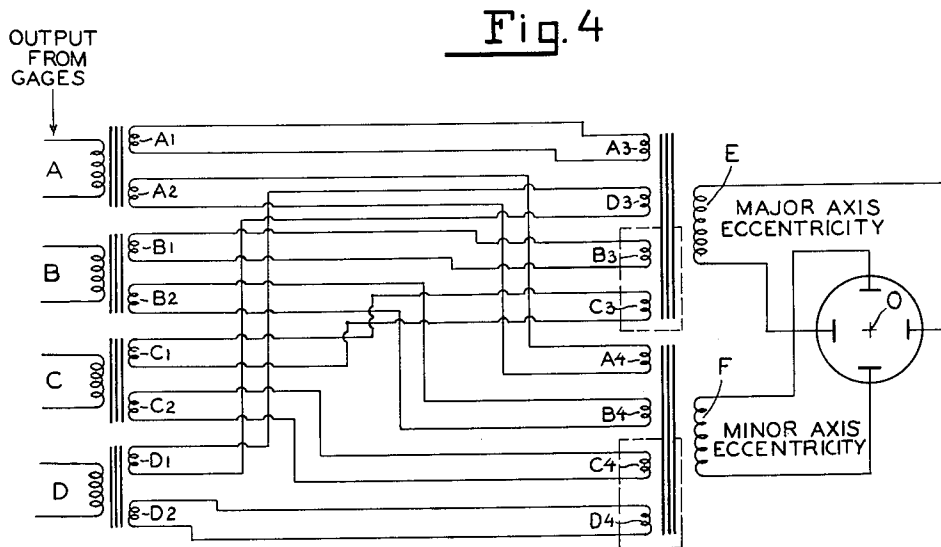
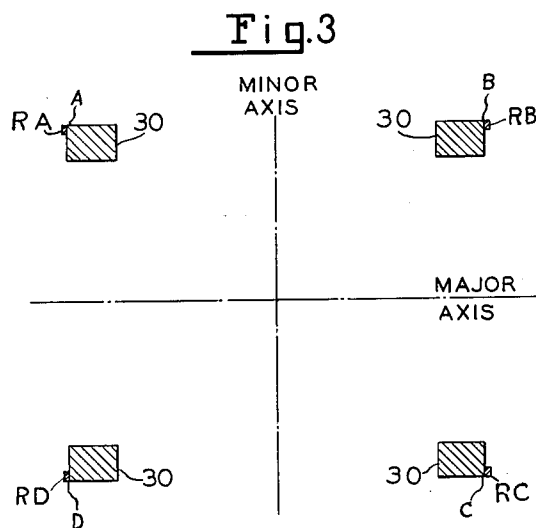
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MEANS FOR INDICATING LOAD ECCENTRICITY IN PRESSES

Alexander Zeitlin, White Plains, Leon Mollick, Brooklyn, and Frederick T. Morrison, Forest Hills, N. Y., assignors, by mesne assignments, to Baldwin-Lima-Hamilton Corporation, Philadelphia, Pa., a corporation of Pennsylvania

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6 Claims. (Cl. 73—88.5)

This invention relates to presses and the like and particularly to hydraulic type forging presses of relatively large capacity, including presses of the push-down type and presses of the pull-down type. In all such presses, it is desirable that the center of pressure of the force or load such as the forging load shall coincide with the central axis of the press. If for any reason the center of pressure of the forging load is displaced with respect to the central axis of the press, there is caused a cocking action of the upper cross head or entablature which is proportional to the product of the total forging load and the distance from the center of the press to the axis of the load. Since the upper entablature is rigidly attached to the columns or tie rods or other frame elements of the press, any cocking action of this upper entablature will cause an equal enforced rotation of the column at the point of attachment. The effect of this rotation is to produce a bending stress in the column which varies linearly across the cross-section of the column. This bending stress is in addition to the direct tension stress in the columns during forging and may be computed by the beam flexure formula.

Since extremely large forces may be developed in the tie rods of the press during normal operation, it will be apparent that the addition of bending stresses caused by the displacement of the center of pressure of the forging load may cause dangerous conditions to arise which may damage the press. It is therefore one of the principal objects of this invention to provide means for visually indicating the position of the center of pressure of the forging force or load with respect to the center of the press bed, so that throughout the forging stroke there will be a continuous indication of any displacement of the forging load. This will enable an operator to take appropriate steps to correct the condition, or automatic responsive means may be employed to give suitable warning signals or to stop the press when such displacement reaches dangerous proportions.

Further objects and advantages of this invention will become apparent in the following detailed description thereof.

In the accompanying drawings,

Fig. 1 is a side elevation of a forging press of the pull-down type to which this invention may be applied.

Figs. 2A and 2B are sections of a portion of the press shown in Fig. 1, indicating diagrammatically the distribution of stress in the tie rods.

Fig. 3 is a section, largely diagrammatic, of the press of Fig. 1 in plan.

Fig. 4 is a wiring diagram.

While the invention is described herein as applied to one type of hydraulic forging press, it will be apparent that it has general application to any type of press and the like which comprises members movable relative to each other along a predetermined axis to exert a force on work material disposed therebetween and includes frame elements subject to strain resulting from such force,

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and in which conditions may occur causing displacement of the force with respect to said predetermined axis.

Referring to the type of press illustrated in Fig. 1, there is shown a vertical forging press of the pull-down type comprising a fixed lower platen 10 having a die support or bolster 11, and a movable upper platen 12 having a die support or bolster 15. The fixed platen 10 is mounted on a bed structure indicated generally at 22 which rests through supports 23 on a suitable foundation 20 below floor level 21, while the movable platen 12 is connected to the movable upper cross head or entablature indicated generally at 14. The work piece to be forged is placed upon a die on the die support 11, and the forging is accomplished by lowering the upper platen to compress the workpiece between dies on supports 15 and 11. The upper platen is normally maintained in elevated position by causing cylinders 25 which are fixed to said platen to be lifted on pistons or rams 26 fixed to the lower platen 10. The elevation is achieved by introducing fluid under pressure from a suitable source (not shown) into the cylinders 25.

To move the upper cross head and platen downwardly toward the lower platen, there are provided a plurality of frame elements in the form of columns or tie bars indicated generally at 30 which may be of rectangular cross-section as shown or may be round, and which are connected at one end to the cross head 14 and at the other end to a movable lower cross head indicated generally at 31. The latter in turn is connected to rams or pistons 32 operating within cylinders 33 fixed to the bed 22. When fluid under pressure is admitted to cylinders 33, rams 32 are forced downwardly, carrying therewith the lower cross head, the columns and the upper cross head, thus applying a force to the work piece.

Extremely high forces are developed between the die supports 11 and 15, and correspondingly large stresses will be developed in the tie rods. It will therefore be understood that it is highly desirable to ascertain whether the forging load is being applied eccentrically of the central axis of the press, since such eccentric application of load will add materially to the already high tension stresses in the tie rods and thus may create dangerous operating conditions. Thus referring to Figs. 2A and 2B, there are illustrated diagrammatically the conditions which prevail when there is no forging load eccentricity as compared to the conditions which prevail when there is eccentric forging. Fig. 2A indicates by means of the plurality of arrows that when there is no forging load eccentricity only the normal stress distribution S_t is present, while when the condition of eccentric forging exists as shown in Fig. 2B there is present also, in addition to the normal stress S_t , the bending stresses caused by the rotation of the upper entablature through an angle. The bending stress distribution shows that it varies from a compressive stress $-S_b$ to a tension stress $+S_b$. Thus at the outer edge A of the left hand column 30, the total stress is $S_t - S_b$, whereas at the inner edge the total stress is $S_t + S_b$. At the inner edge of the right hand column, the total stress is $S_t - S_b$, whereas at the outer edge B, the total stress is $S_t + S_b$. Therefore, referring to Fig. 3, if the stresses were measured at point A on one column or tie rod 30 and at point B on the column on the opposite side of the minor axis of the press, and their outputs were subtracted, the difference would be proportional to S_b and would be an indication of the eccentricity along the major axis as indicated in Fig. 3. In the case of eccentricity along the major axis only, if the stresses were measured at points C and D on the columns 30 on the other side of the major axis, the difference in output at points C and D would be the same as the difference between points A and B, and if these values were added together, the output differences due to eccentricity along

the major axis would be doubled. Similarly, if the differences in stress were measured at points A and D, and B and C, there would be obtained a value that was proportional to a displacement only in the direction of the minor axis. Any combination of eccentricity can be determined by the simultaneous measuring of the components in the direction of the major and minor axes.

Therefore, if four strain responsive members or gauges RA, RB, RC, RD were positioned on the four tie rods 30 at positions A, B, C and D, values corresponding to the eccentricity in the major axis direction and the minor axis direction could be obtained by connecting said strain gauges as follows:

(1) $(A-B) + (D-C) \sim$ eccentricity in major axis direction.

(2) $(A-D) + (B-C) \sim$ eccentricity in minor axis direction.

Electrical impulses corresponding to the algebraic sums in (1) and (2) above may be indicated in various ways, as for example by causing the result of each of said outputs to actuate separate pens on a moving chart, but this method would require calculation and the formation of a mental picture before an operator could determine in which direction the center of pressure of the forging load is operating with respect to the center of the press. Therefore by this invention we prefer to employ a cathode ray oscilloscope in which the electron beam which strikes the oscilloscope screen as a bright spot can be moved in the two directions corresponding to the major and minor axes of Fig. 3. Thus an instantaneous indication of the position of the center of pressure of the forging load with respect to the center of the press is obtained by merely noting displacement of the bright spot on the oscilloscope screen from its central position O. For this purpose the output (1) above may be applied to the horizontal plates of the oscilloscope to displace the spot in the major axis direction, whereas the output corresponding to (2) above may be applied to the vertical plates of the oscilloscope to displace the spot in the minor axis direction. Thus the position of the bright spot on the oscilloscope may be caused to correspond directly to the position of the center of pressure of the forging load with respect to the center of the press. The face of the oscilloscope may be suitably calibrated, and, if desired, a mask may be provided on the oscilloscope face covering the safe area, so that only if the spot projects beyond said mask will a dangerous situation be indicated. Not only is the magnitude of deviation indicated, but also the exact direction in which said deviation is being applied.

In order that the outputs from the strain gauges may be effective to indicate in both directions, each strain gauge output is caused to energize the primary coil of a transformer as shown in Fig. 4 and each primary coil induces voltage in two secondary coils. Thus the primary coil energized from the strain gauge RA at A induces voltage in two secondary coils A1 and A2, the primary coil energized from the strain gauge RB at B induces voltage in secondary coils B1 and B2, and so forth. Each pair of secondary coils is connected to a pair of primary coils A3, A4, B3, B4, etc. The sets of primary coils A3, B3, C3, D3, induce voltage in secondary coil E which applies voltage to the horizontal plates of the oscilloscope. The primary coils A4, B4, C4, D4, induce voltage in secondary coil F to apply voltage to the vertical plates of the oscilloscope. The primary coils B3, C3, and C4, D4, which are shown enclosed in dotted lines are wound in a direction opposite to the windings of the primary coils A3, D3, A4, B4. Now referring again to the algebraic sums (1) and

(2), it will be seen that as A3 increases or decreases, B3 decreases or increases, and as D3 increases or decreases, C3 decreases or increases correspondingly, thus giving the algebraic sums which define the eccentricity in the major axis direction and which are applied to coil E. Similarly referring to the algebraic sum (2), it will be seen that when A4 increases or decreases, D4 decreases or increases, and when B4 increases or decreases, C4 decreases or increases correspondingly to give the algebraic sums which define the minor axis eccentricity which is the voltage applied to coil F.

Having described our invention, what we claim and desire to secure by Letters Patent is:

1. In a press and the like having members movable relative to each other along a predetermined axis to exert a force on work material disposed between said members, and a plurality of similar frame elements symmetrically arranged with respect to said predetermined axis so as normally to be subjected to similar and equal stresses when there is no deviation of the axis of said force with respect to said predetermined axis, means for indicating positional deviation of the axis of said force with respect to said predetermined axis of the press, said means comprising a plurality of strain responsive members, each member being mounted on a respective frame element, said strain responsive members being operatively connected in pairs disposed on opposite sides of said predetermined axis in a plurality of directions, and an indicator having separate means responsive to the differential of the responses of the respective pairs of strain responsive members.

2. An indicating device as specified in claim 1, in which said predetermined axis is the central axis of the press.

3. An indicating device as specified in claim 2, in which said pairs of strain responsive members are arranged in quadrature.

4. An indicating device as specified in claim 2, in which said pairs of strain responsive members are arranged along lines parallel to major and minor axes of the press in a horizontal plane.

5. An indicating device as specified in claim 4, in which the differential of each pair of strain responsive members is converted into a signal voltage, and the indicator is an oscilloscope comprising a screen, means for projecting an electron beam on the screen, and vertical and horizontal sets of plates for deflecting said beam in a plurality of directions, the signal voltages from one pair of strain responsive members being applied to one pair of oscilloscope plates, and the signal voltages from the other pair of strain responsive members being applied to the other pair of oscilloscope plates.

6. An indicating device as specified in claim 5, in which the oscilloscope comprises pairs of plates arranged with respect to the central axis of the oscilloscope in positions corresponding to the positions of the respective pairs of strain responsive members, and the signal voltages from the respective pairs of strain responsive members are applied to the correspondingly positioned pairs of oscilloscope plates.

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