

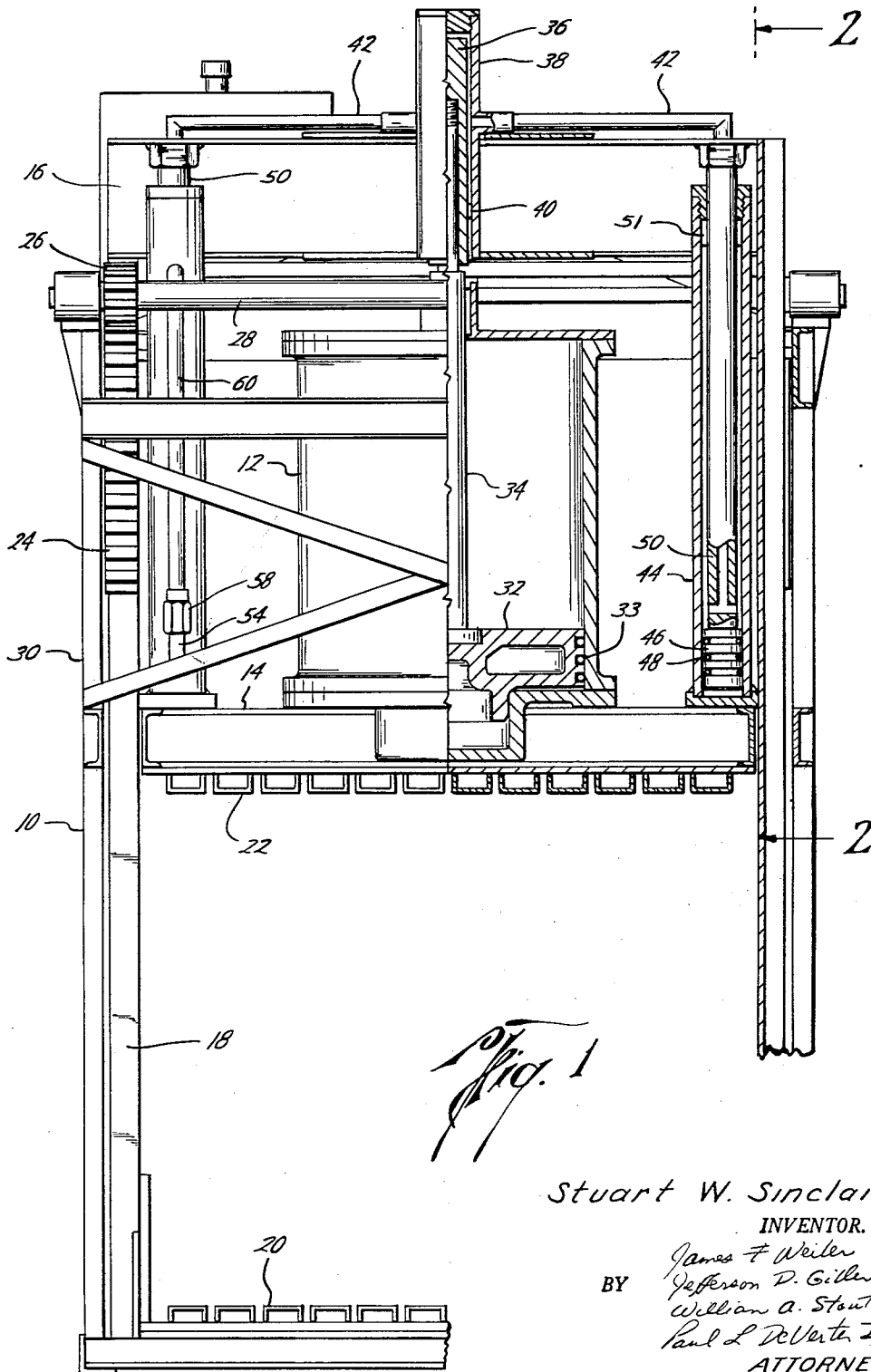
Feb. 25, 1964

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INTENSIFIED PRESS

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Filed July 24, 1961

5 Sheets-Sheet 1



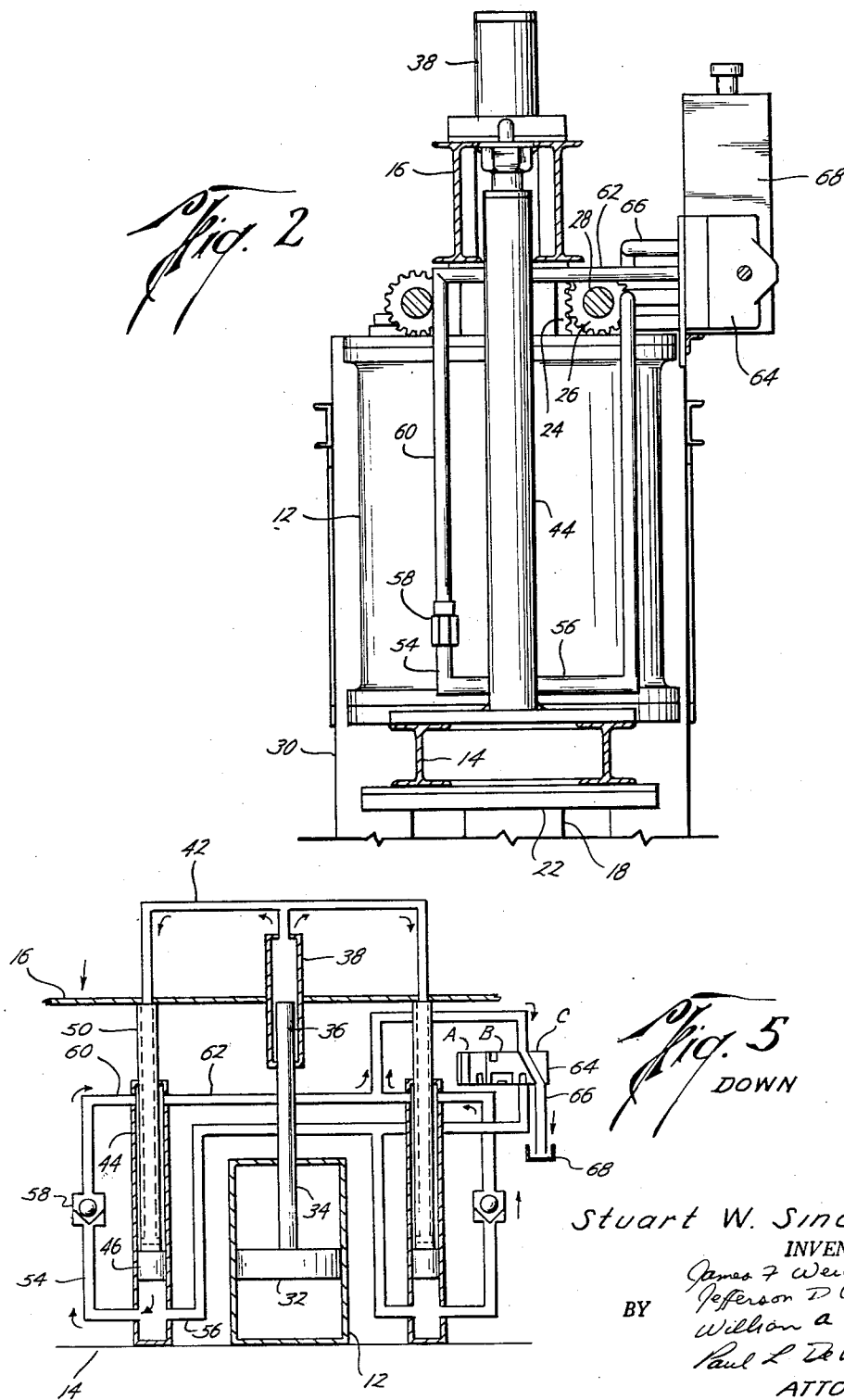
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Fig. 3
RAPID
CLOSURE

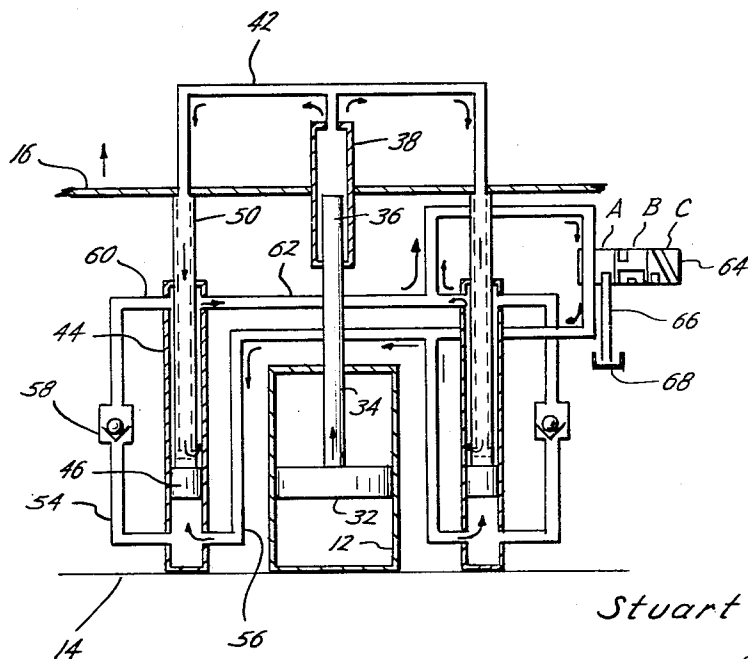
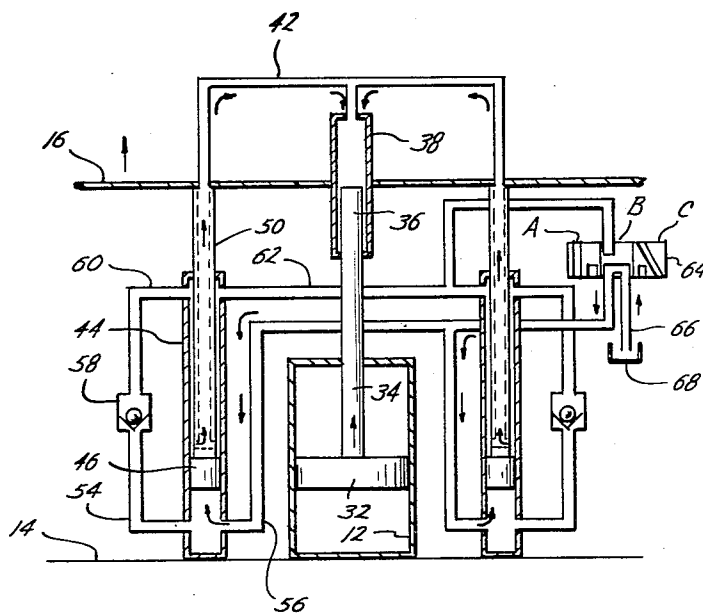


Fig. 4
HIGH
COMPRESSION

Stuart W. Sinclair

INVENTOR.

BY James F. Weiler
Jefferson D. Giller
William A. Stout
Paul L. DeVerte II
ATTORNEYS

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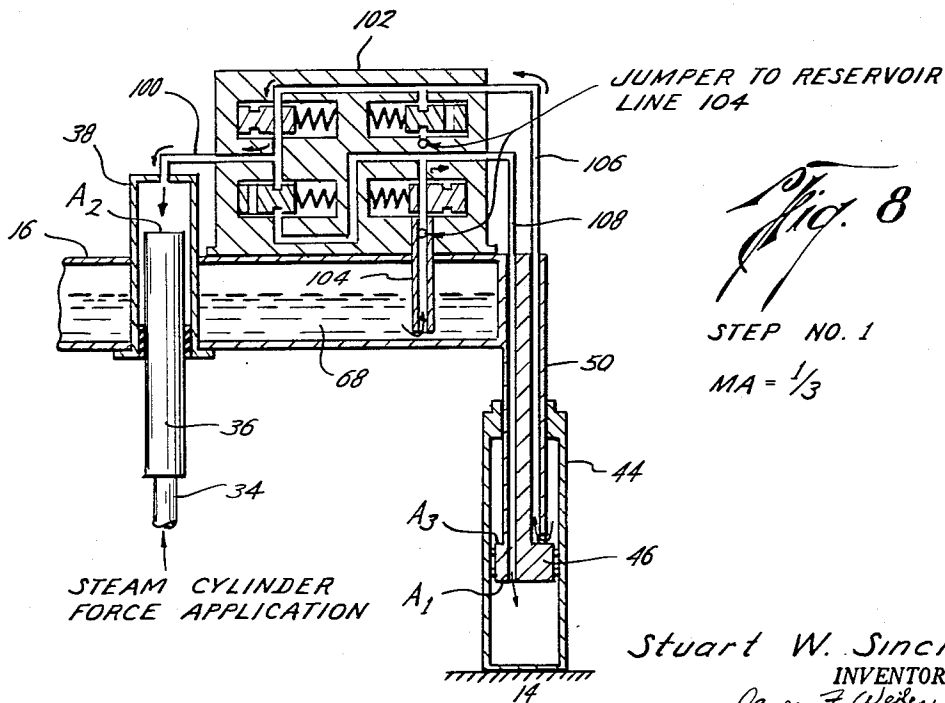
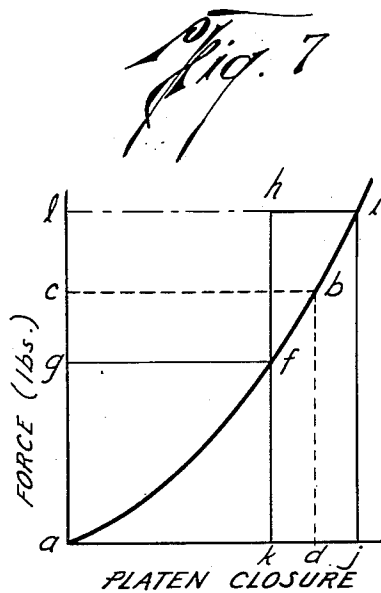
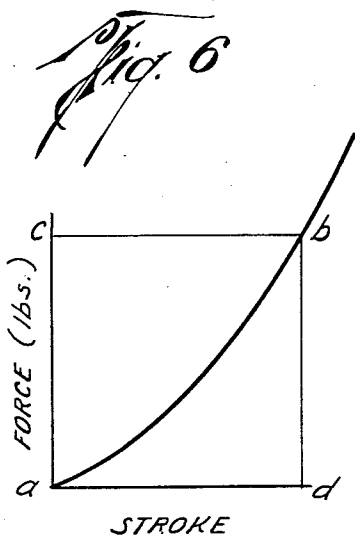


Fig. 8

STEP NO. 1

$MA = \frac{1}{3}$

Stuart W. Sinclair
INVENTOR.
James F. Weber
Jefferson D. Gilley
William A. Stout
Paul L. DeVerte &
ATTORNEYS

Feb. 25, 1964

S. W. SINCLAIR
INTENSIFIED PRESS

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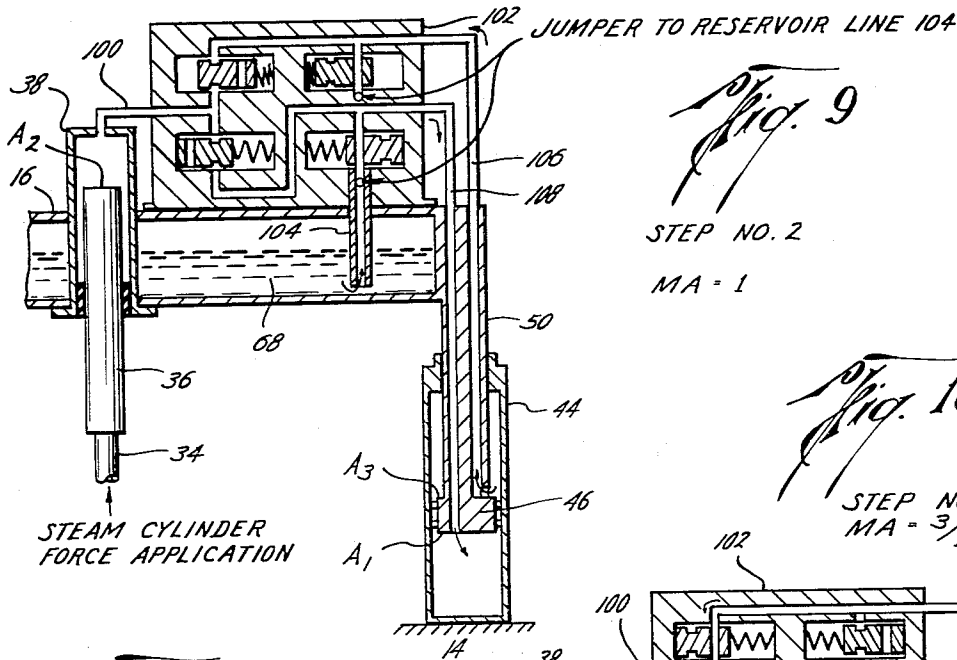
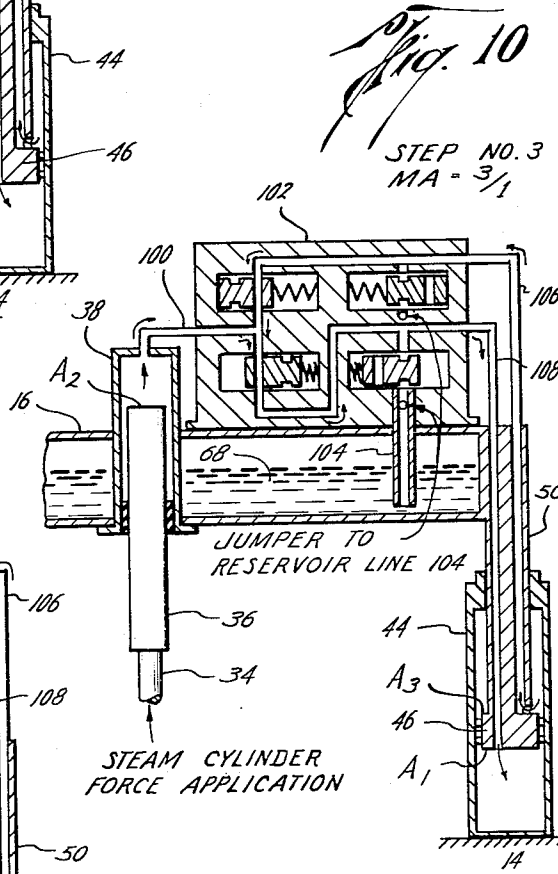
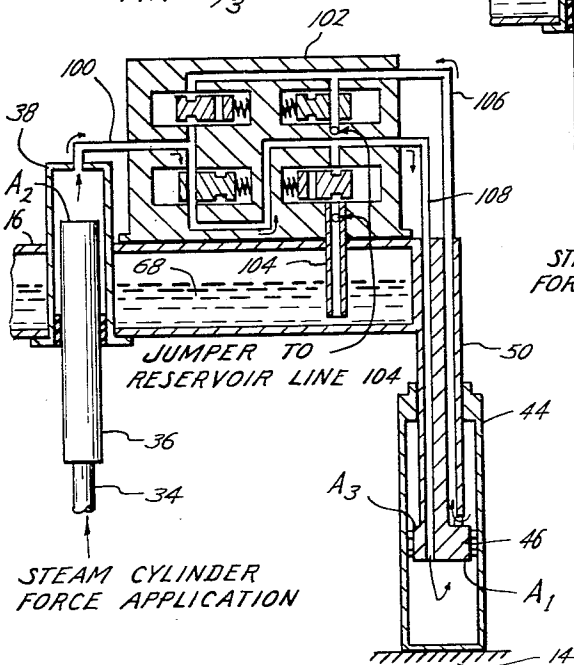


Fig. 11

STEP NO. 4

MA = $\frac{11}{3}$



Stuart W. Sinclair
INVENTOR.

BY James F. Wheeler
Jefferson D. Giller
William A. Stout
Paul L. DeVerte
ATTORNEYS

1

3,122,092

INTENSIFIED PRESS

Stuart W. Sinclair, Houston, Tex., assignor to Anderson, Clayton & Co., Houston, Tex., a corporation of Delaware

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11 Claims. (Cl. 100-269)

The present invention relates to an improved platen press, and more particularly to a press having an intensifier which is hydraulically and mechanically connected so that the mechanical advantage obtained while pressing may be varied.

The present invention is directed to a combined press and intensifier which is suitable for use in any pressing operation where the combination of fast press platen movement at relatively low power and also relatively slow movement at great power is desired, as well as various intermediate steps. The present invention is particularly suited for the compression of materials whose force-stroke curve is non-constant, such as cotton. The intensifier or booster of the present invention is well suited for addition to the conventional "dinky" press, whereby not only may the retaining bands be removed from gin flat cotton bales, but also the higher density compress standard bales.

For many years intensifiers have been used as a part of the hydraulic circuitry in large compresses for densifying baled cotton. Patented examples are Taylor, 167,363 of August 31, 1875, and Webb, 996,693 of July 4, 1911. The purpose of these intensifiers is to convert low pressure steam to high pressure hydraulics. Almost invariably the steam cylinder and intensifier are mounted off the press itself. Consequently the stroke of the intensifier can be no less than that of the steam cylinder, and the hydraulic cylinders have to supply the full pressing force to the press.

The present invention is directed to the placement of the intensifier and associated hydraulic circuitry on the press itself so that the intensifier cylinder mechanically connects to the moving platen, while the main steam (or other fluid) cylinder mechanically connects to the frame and fixed platen. Further, the mechanical advantage may be varied, manually or automatically, to provide velocities and powers consistent with the load being pressed in a most efficient manner. In so doing, hydraulic circuitry is employed so that the stroke of the press may be varied from that of the main steam cylinder. Finally, the use of the intensifier circuitry is such that the ultimate strength requirement of these hydraulic parts is reduced, hence less expensive equipment is required.

The theory of the present invention may be readily understood by referring to FIGURE 6. Curve *a-b* of FIGURE 6 represents a typical compression curve for cotton when the pounds force (vertical) is plotted against the stroke or platen closure (horizontal) in a conventional dinky press wherein the main cylinder is directly connected to the moving platen. As an example, the area *adbc* represents the total work or energy (ft.-lbs.) available and supplied to compress a cotton bale when using steam, or other fluid, supplied at constant final pressure to the main cylinder. The area *adb* under the curve represents the total work actually needed and used to compress the cotton bale. It is, therefore, evident that the remaining energy, represented by the area *abc*, is wasted because it is supplied but not utilized.

One of the objects of the present invention is to utilize this energy which is normally wasted. The method utilized may be understood by referring now to FIGURE 7, which shows the same compression curve *a-b* and its extension. The method generally comprises rearranging the total energy supplied by varying the mechanical ad-

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vantage. Of course, this means that the main cylinder stroke is not now comparable to the platen closure. Thus, if the cotton is compressed along curve *ab* to *f* in the first step, then the energy supplied is represented by the area *akfg*, of which area *akf* is utilized usefully, and area *afg* is wasted. The total available energy, as before, is represented by the area *adbc*, of which only *akfg* has been expended. Therefore, a considerable amount of energy remains to be expended, which is represented by the area *gfkdbc*. By changing the mechanical advantage of the press and redistributing this remaining energy into the area *kjih* (or *kdjihf*), it is readily seen that the total force applied to the cotton bale has been increased from *c* to *l*, while the platen closure has increased from *d* to *j*. Therefore, the density of the cotton has increased from *b* to *i*, all without the addition of any more energy than was originally available, and simply by a change of mechanical advantage. It is, of course, apparent that additional steps may be incorporated to further increase the density.

While the foregoing discussion of energy rearrangement is somewhat conventional, the present invention changes the mechanical advantage in a unique manner. That is, the intensifier is mechanically connected to the moving platen of the press and the main cylinder. Further, the main cylinder force is always acting directly on the moving platen and therefore the load. This advantageously results in the hydraulic press cylinders supplying only the increase in pounds force over that supplied by the main steam cylinder, hence these hydraulic parts may be of a reduced strength capacity. Secondly, the stroke of the intensifier need not be as long as that of the main cylinder, resulting in the use of smaller physical lengths and therefore less expensive equipment. The third advantage of the present invention is that with a single acting intensifier four pressing mechanical advantage combinations are available, and with a double acting intensifier, seven or more.

To secure these advantages and features then are additional objects of the present invention. Further, it is an object of the present invention to provide an intensified press wherein the main cylinder acts directly on the load and on the intensifier.

Another object of the present invention is to provide an intensified press whose mechanical advantage may be varied, manually or automatically, by the use of an intensifier and auxiliary rams in predetermined steps so as to utilize the maximum amount of energy which is available in actually compressing the load.

While the present invention is well suited for use in the construction of new presses, it is also quite useful in reconstructing and increasing the capabilities of old presses. In particular, the present invention is well suited for the dinky press. As the principles of operation are the same, whether the press be large or small, the following discussion is directed particularly to a dinky press, but it is understood that the invention is in no way limited thereto.

In the processing of cotton, for ease of transportation and storage, the cotton is often tied into bales with metal bands or ties. Over the course of time, three sizes of bales have evolved. All of these bales contain the same amount of cotton and the only difference is in the density of the cotton packed therein, which is, of course, due to the final size of the bale. After the cotton has been picked and run through the gin, it is baled into a more or less rectangular solid having dimensions approximately 55 (length) x 45 (height) x 28 (width) inches. This bale is called the gin bale and is usually held together with six steel bands.

Thereupon, the gin bales are shipped to the compress which has more and heavier equipment so that the size

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of the bale may be reduced. This reduced bale has dimensions generally about 55 x 22 x 28 inches and is called the compress standard bale. Notice that the only dimension change was the height from 45 to 22 inches. The compress standard bale is the size normally used for domestic shipments and for storage at the compress warehouses. The compress standard bale typically has eight bands.

When overseas or foreign shipment of cotton is desired, then the standard bale must be further reduced in size or the gin bale reduced in size from that of the standard bale for reasons of cost and storage. Thus, the third bale has dimensions generally about 52 x 20 x 20 inches with nine bands. This is the high density bale or, as it is commonly known, the export bale.

In each instance, when one size bale is compressed to make the next smaller size bale, the bands surrounding the bale must be removed before the bale may be placed in the particular cotton press which makes the new and smaller bale. The function of the dinky press is to squeeze the gin bale sufficiently so that the six steel bands surrounding it are loosened, whereupon the workmen may cut and remove the bands before the gin bale is placed in the compress. The design of dinky presses has remained essentially the same for the last seventy-five years and, of course, there are many in existence. The dinky press was designed specifically for compressing the gin bale to remove the bands. Normally, the dinky press does not have the power which is needed to compress the standard bale so that its bands may be removed when making an export bale. The dinky press ordinarily has a distance between the platens slightly in excess of 45 inches as it is normally used only to compress cotton bales of this height, i.e. the gin bale, when removing the six bands. Thus, even if the dinky press had the power to further compress the standard bale, so that its bands could be removed, the press would have to have a vertical spacing between the platens to approximate 22 inches before the standard bale would begin to be compressed between the platens.

Nonetheless, the dinky press is adequate for use with the standard bale in band removal, when the problems of speed and power are overcome. Specifically, if the dinky press platens were capable of rapid closure so that the size of the standard bale is quickly approximated, and if thereafter the dinky press has sufficient power to overcome the higher density of the standard bale, then it is apparent that the dinky press may be used not only in compressing gin bales to remove the bands, but in compressing standard density bales to remove the bands in preparation of high density or export bales. The present invention is adapted to be utilized with the existing dinky press so that both of these problems are overcome, thereby providing a fast platen closure movement and thereafter a slower movement with great power.

Thus, it is an object of the present invention to provide an improved press, such as a dinky press, having a much quicker platen movement than has heretofore been utilized.

It is a further object of the present invention to provide an improved dinky press having a variable mechanical advantage.

Another object of the present invention is to provide a booster for use with a conventional dinky press which serves to quickly move the press platens together.

Another object of the present invention is to provide a booster for a dinky press which greatly boosts the power output of the press, so that standard density as well as gin bales may have their bands removed in the dinky press.

Still another object of the present invention is to provide a booster for use with a conventional press which will vary the mechanical advantage obtained from the constant mechanical advantage press.

Yet a further object of the present invention is to pro-

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vide a dinky press having a booster which is capable of replacing presses presently used at the compress to remove the bands from the standard density bale.

A still further object is to provide a booster for use with a conventional press which increases the total stroke of the press in a telescoping manner.

Another object is to provide a booster which increases the total stroke of a conventional press and provides at least two modes of operation, a rapid closure, and a slower, more powerful closure.

Another object of the present invention is to provide an intensified press which utilizes input energy heretofore wasted.

Other and further objects, features and advantages will be apparent from the following description of a presently preferred embodiment of the invention, given for the purpose of disclosure, and taken in conjunction with the accompanying drawings, where like character references designate like parts throughout the several views, and where:

FIGURE 1 is a partial front view, partially in section, of a dinky press having the present invention installed thereon,

FIGURE 2 is a partial side view of the improved dinky press taken along the line 2-2 of FIGURE 1,

FIGURE 3 is a schematic piping diagram of one form of the present invention when applied to a dinky press and showing the fluid movement in the fast closing mode,

FIGURE 4 is a schematic diagram similar to FIGURE 3 showing the fluid movement in the power closure mode,

FIGURE 5 is a schematic diagram similar to FIGURE 3, showing the fluid movement in the press opening mode,

FIGURE 6 is a representative compression curve for cotton showing the energy distribution of a conventional dinky press,

FIGURE 7 is a curve similar to FIGURE 6 showing the redistribution of energy when the present invention is applied to a dinky press,

FIGURE 8 is a partial schematic piping diagram, somewhat similar to FIGURES 3-5, of one form of the present invention when applied to a 4-step press in the rapid closure mode,

FIGURE 9 is a schematic diagram similar to FIGURE 8, showing an intermediate pressing step,

FIGURE 10 is a schematic diagram similar to FIGURE 8, showing a further intermediate pressing step, and

FIGURE 11 is a schematic diagram similar to FIGURE 8, showing the final pressing step.

Referring now to the drawings, and particularly to FIGURE 1, the reference numeral 10 generally designates the dinky press, having a main steam cylinder 12 bottomed on the transverse frame member 14 and conventionally connected, as hereinafter described, to the crosshead 16 which raises the upright members 18 so as to lift the lower platen 20 upwardly toward the fixed upper platen 22. A rack 24 attached to the upright lift member 18 engages with the pinion 26 and shaft 28 to insure equal vertical movement of both sides of the lower platen 20. The transverse frame 14 and pinion shaft 28 are supported by the main vertical frame 30. All of the above mentioned devices are conventional and have been found on dinky presses for at least seventy-five years, and as their operation is conventional, no further explanation thereof is deemed necessary.

The dinky press includes the main steam cylinder 12 provided with the piston 32 having the usual packing 33 and attached to the piston 32 is the conventional piston rod 34 which causes movement of the crosshead 16. In the present invention the piston rod 34 is extended and forms a hydraulic piston 36. Surrounding the piston 36 is an intensifier cylinder 38 which is attached to and moves with the crosshead 16. This hydraulic intensifier cylinder 38 includes the usual packing 40 to retain hydraulic fluid within the cylinder 38.

The hydraulic line 42 connects the interior of the in-

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tensifier cylinder 38 with the interior of the upper part of the press cylinder 44. The hydraulic press cylinder 44 is mounted on the transverse frame member 14. Within the press cylinder 44 is a piston 46 having the usual packing 48. The piston 46 has a connecting rod 50 containing an internal passageway which is connected to the hydraulic line 42 so that hydraulic fluid within the upper part of the press cylinder 44 communicates with the hydraulic fluid within the cylinder 38. Surrounding the rod 50 in the upper part of the cylinder 44 is additional typical packing 51. Rod 50 is conventionally attached to the crosshead 16.

The press cylinder 44 is double acting in that hydraulic fluid also communicates with the press cylinder in its lower part by means of the hydraulic lines 54 and 56, both of which hydraulic lines are best seen by referring to FIGURE 2 and the schematic views of FIGURES 3 through 5. Attached to the hydraulic line 54 is a check valve 58 whose function is to allow hydraulic fluid to flow in only one direction, from the lower part of press cylinder 44 to the upper part thereof.

From the conventional check valve 58, hydraulic line 60 connects with the end of the press cylinder 44 which contains the piston rod 50, that is the upper part. Also connected to the upper end of the press cylinder 44 is hydraulic line 62 which connects with the 3-way conventional hydraulic valve 64. The hydraulic line 56 connects the press cylinder 44 at the lower end directly with the valve 64. The 3-way hydraulic valve 64 has three positions for varying mechanical advantages and these positions are designated A for slow upward compressive movement of the press with increased power, B for rapid compressive movement, and C for the opening position of the press. Hydraulic line 66 connects the valve 64 to the oil reservoir 68.

Briefly, in use, steam or other fluid is supplied to the main steam cylinder 12. Thereupon, the present invention either adds or subtracts mechanical advantage to the conventional movement of the piston 32 and its rod 34 by a proper selection of the various positions of the hydraulic valve 64. Throughout this description, the main cylinder 12 is referred to as a steam cylinder, however, it is obvious that the present invention may be equally utilized with other fluid types of main cylinders. Further, the hydraulic fluid referred to may be any relatively incompressible fluid.

Referring now to the schematic diagram of FIGURE 3, the physical and fluid movements are shown when the press platens are being rapidly closed. This hydraulic circuit may be described as a bootstrap circuit or approach stroke, since very little movement of the main steam piston 32 results in a greater movement of the crosshead 16 and therefore of the lower platen 20. In FIGURE 3, many of the components are represented only diagrammatically to eliminate unnecessary lines on the drawing and so that the principles of operation are more readily seen. Likewise, although two booster cylinders are shown, only one is generally referred to, as the operation of both is identical and simultaneous. As previously mentioned, the main steam cylinder 12, which may be double acting, is mounted on the transverse frame member 14. Also mounted on the transverse frame member 14 is the hydraulic press cylinder 44. Attached to the crosshead 16 are the hydraulic intensifier cylinder 38 and the piston rod 50. The main steam piston 32 acts through the rod 34 and piston 36 on the hydraulic fluid within the intensifier cylinder 38. The effective piston area of intensifier piston 36 is greater than that of the sum of the upper piston areas of press piston 46 within the press cylinder 44.

Valve 64 is placed in position B.

As steam is supplied to the lower part of main cylinder 12, the main piston 32, rod 34 and intensifier piston 36 move upwardly. The relatively incompressible hydraulic fluid in intensifier cylinder 38 attempts to flow through line 42 and hollow rod 50 into the upper part of press

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cylinder 44. However, flow out of press cylinder 44 is not permitted due to the closed check valve 58 in line 60 and the closed position B of valve 64 relative to line 62. Therefore, as the hydraulic fluid does not substantially compress, the hydraulic fluid must remain in intensifier cylinder 38, and thus the intensifier cylinder 38 and attached crosshead 16 must move upwardly the same distance as the main piston 32.

But the upward movement of the crosshead 16 pulls the attached rod 50 and press piston 46 upwardly within press cylinder 44. This increases the pressure on the hydraulic fluid in the upper part of press cylinder 44. The same hydraulic fluid as before is affected, and as it has no place to go except into intensifier cylinder 38, the hydraulic fluid flows in the direction of the arrows from press cylinder 44 through rod 50, line 42, and into intensifier cylinder 38, increasing the volume of fluid in the intensifier cylinder 38. Therefore, the intensifier cylinder 38 and crosshead 16 must again move upwardly to account for this fluid displacement from the upper part of press cylinder 44. Thus the bootstrap operation raises the crosshead 16 much more than the total movement of main piston 32; and the platen 20, connected to the crosshead 16, rises rapidly. Of course, as the press piston 46 moves upwardly, fluid is drawn from the reservoir 68, through line 66, position B of valve 64, and line 56 into the bottom part of press cylinder 44. This bootstrap operation is due to the previously mentioned differences in effective piston areas and the hydraulic connections which result in the mechanical advantage being less than unity.

It is apparent that the stroke of the press 10 has been substantially increased by the bootstrap action of the hydraulic cylinders. The total movement of the movable lower platen 20 is no longer limited to the total stroke of main piston 32 within the main steam cylinder 12, but, by the use of the present invention, is potentially increased to the sum of the strokes of pistons 36 and 32. The platen stroke in this step is dependent upon the effective face areas of the intensifier piston 36 and the upper part of press piston 46.

In this manner, the platens are rapidly closed upon the standard density bale in a minimum of time and work input, so that the press is now ready to squeeze the bale for band removal. In this operation, with the higher density standard bale as compared to the gin bale, more compressive strength or leverage is needed than the typical dinky press is capable of providing. However, in the present invention this deficiency is overcome by switching the valve 64 to position A, as shown in FIGURE 4. Now the hydraulic circuit provides considerable mechanical advantage and therefore proportionately more movement of the main piston 32 is required to produce movement of the crosshead 16 and platen 20.

Thus, referring to FIGURE 4, the invention will provide a slower closing movement of the platens with considerably increased power. As steam is supplied to the lower part of main cylinder 12, the main piston 32, rod 34, and intensifier piston 36 rise upwardly. Following the arrows shown in this schematic diagram, the hydraulic fluid in intensifier cylinder 38 is forced into the line 42, through the rod 50, into the upper part of press cylinder 44 and into line 62. Again the check valve 58 prevents flow into line 60. Then the flow of hydraulic fluid continues from line 62, through portion A of valve 64, and line 56, into the lower part of press cylinder 44, and acts against the lower face of piston 46. Notice that position A of valve 64 also stops flow in line 66 communicating with the reservoir 68. Therefore, as trapped fluid is displaced from intensifier cylinder 38, it is forced into the lower part of press cylinder 44, and raises the press piston 46 upwardly. The upward movement of press piston 46 acting through rod 50, raises the crosshead 16 (thus raising the lower platen 20) and the intensifier cylinder 38 attached to the crosshead.

The effective piston area of intensifier piston 36, as was

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previously mentioned, is greater than the sum of the areas of the upper face of press piston 46. However, the sum of the effective piston areas of the lower face of press piston 46 is greater than that of intensifier piston 36. This effective area of press piston 46, of course, is obtained by subtracting the effective area of the upper face of press piston 46 from the area of the lower face. Thus as fluid is displaced from intensifier cylinder 38 by the stroke of intensifier piston 36, this same volume is placed into the lower part of press cylinder 44, where the area is greater; therefore, the height or stroke of press piston 46 is smaller than that of intensifier piston 36. Consequently, the leverage is increased because the greater movement of main piston 32 or intensifier piston 36 results in a smaller movement of crosshead 16 and platen 20; hence the force applied to the platens is increased.

It is possible, by using various piston face areas, to provide innumerable variations in both the bootstrap circuit of FIGURE 3 and the power circuit of FIGURE 4. For example, if the sum of the effective areas of the lower face of press piston 46 equals that of intensifier piston 36, a mechanical advantage of two is gained when the valve 64 is in position A, and the stroke of piston 36 is twice that of the crosshead 16, this form being useful as a power stroke because the force applied by the moving platen 20 is twice that applied by the main steam cylinder 12 or intensifier piston 36.

After the bale has been sufficiently compressed, and the bands removed, then the platens must be opened so that the bale may be removed for further processing. Referring now to FIGURE 5, the valve 64 is changed to position C, for the nonpowered return of the platens. The main steam cylinder 12 is vented, and the main piston 32, rod 34 and intensifier piston 36 drop downwardly of their own weight. Hydraulic fluid is sucked from the reservoir 68, through line 66, position C of valve 64, line 62, the upper part of press cylinder 44, rod 50 and line 42, into intensifier cylinder 38. Thereafter the crosshead 16 begins to drop downwardly, and the flow changes to that shown by the arrows in FIGURE 5. Thus the now large volume of fluid in intensifier cylinder 38 is reduced as the attached crosshead 16 falls. The flow is out of intensifier cylinder 38, through line 42, rod 50, and into the upper part of press cylinder 44, to fill the void created by the lowering of piston 46. Depending upon the difference in piston areas, there may be an excess of fluid being pushed from the lower part of press cylinder 44, by piston 46, through line 54, check valve 58, line 60, the upper part of press cylinder 44, line 62, position C of valve 64 and line 66 into the reservoir 68.

Of course, the two flows described in the downward movement may take place simultaneously or in a different order, depending upon the inherent frictional resistance of the various cylinder arrangements and the respective weights of the many components. In some instances, if the packing is particularly tight, steam may have to be applied to the upper part of main cylinder 34 to move the piston 32 downwardly and thus start the chain of events.

In all of the above circuits, generally only one of the two press cylinders 44 and corresponding parts were described. However, the schematic views of FIGURES 3-5 show a dual system. The operation of a dual system, or triple or more, is identical and simultaneous with that above described. The relative areas of the effective piston faces must be maintained, however, in that the sum of the effective piston faces of the piston 46 in the upper part of press cylinder 44 must be smaller than that of piston 36 in intensifier cylinder 38.

In a dual system, the press pistons 46 and rods 50 operate in tandem, hence if the orifices, piping, or the like, are not identical, the crosshead 16 may tend to bind or become skewed. The racks 24, gears 26, and shafts 28 form an equalizer system to prevent movement on one side of the press 10 without corresponding movement on the

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other. This equalizer system is well known in the press art, and thus need not be further explained.

The rigid hydraulic line 42 and hollow rod 50 are utilized in deference to a flexible line connecting intensifier cylinder 38 with the upper part of press cylinder 44, since there are no hoses, or the like, in which to become entangled, and fewer moving parts. Preferably, the line 42 is rigid and moves with the crosshead 16. Obviously, either would work well in applying the principles of this invention.

Thus it is seen that the present invention is particularly well suited for adaptation to existing dinky presses, as well as being quite useful in other types of presses. In the existing dinky presses, the total delivery pressure has been doubled and the stroke substantially increased by the telescopic action of piston 36 and intensifier cylinder 38, and piston 46 and press cylinder 44. The dinky press, by virtue of the present invention, is capable of handling standard density bales as well as gin bales of cotton.

The above discussion has been directed to utilizing the present invention in the conventional dinky press, by which the stroke of the platens has been increased without an increase in the stroke of the main steam cylinder, and the power has been utilized in two distinct steps of mechanical advantage so that the ultimate power delivered by the dinky press has been greatly increased without increasing the capacity of the main steam cylinder. Therefore, advantageously, the existing press has been made more flexible and useful.

The present invention may be utilized to provide even more combinations of mechanical advantage. By virtue of mechanically connecting the intensifier cylinder to the moving platen, the present invention results in the hydraulic press cylinders having to supply only the increase in force to the load over that supplied by the main steam cylinder. This is because the force of the main steam cylinder is added to that of the hydraulic press cylinders and both are applied to the load in the power stroke. As an example, in a 90-ton press with a 3 to 1 mechanical advantage, the present invention only requires that the hydraulic press cylinders supply 60 tons because the main steam cylinder supplies the remaining 30 tons. To be contrasted with this, even if in the conventional steam intensified hydraulic press there were a mechanical advantage of 3 to 1, the hydraulic press cylinders would necessarily have to exert the full 90 tons. Therefore, the present invention allows the use of smaller hydraulic press cylinders.

In addition to reducing the size of the hydraulic press cylinders, the size of the intensifier is reduced when the intensifier cylinder is mounted on the moving platen. This is because the stroke of the intensifier of the present invention is smaller than the stroke of the main steam cylinder. As an example, in the case of a conventional 3 to 1 mechanical advantage press, the power stroke of the intensifier piston is 3 times the power stroke of the moving platen. In the present invention, the power stroke of the intensifier piston relative to the intensifier cylinder is only two times that of the moving platen because the intensifier cylinder has moved $\frac{1}{3}$ the distance with the moving platen. In both cases the main steam piston has moved 3 times that of the moving platen. Further, in a conventional press, even with a rapid approach circuit, the intensifier stroke must be long enough to include both the power stroke and approach stroke. However, in the present invention the attachment of the intensifier to the moving platen requires that the intensifier stroke need be no longer than the power stroke, for the "bootstrap" approach stroke is subtractive with respect to the power stroke. This is because the intensifier cylinder which is attached to the moving platen is moving in the same direction, at a faster velocity, than the intensifier piston. In other words the stroke of the intensifier is divided into a being pumped into action and then a pumping out action instead of a straight pumping action as in the case of con-

ventional nonmoving intensifiers. Therefore, the present invention allows the use of a shorter length intensifier.

Finally, with the intensifier mounted on the moving platen, four mechanical advantage combinations are available with a single acting intensifier and a double-chambered press cylinder, and seven or more with a double-chambered intensifier. As each mechanical advantage combination represents a distinct step, then the total energy utilized is increased, while the energy wasted is reduced, resulting in a greater density load as compared to a conventional press having the same energy available. Or conversely, to press to the same density as a conventional press, the present invention requires the availability of less total energy, since less energy is wasted. This means that a smaller main steam cylinder is necessary.

Thus, with these advantages, smaller hydraulic press cylinders, a smaller intensifier, and a smaller main steam cylinder, the reduction in size of these items indicates a reduction in cost of the entire press.

To illustrate the present invention when utilized in a press having four pressing steps, reference is now made to FIGURES 8-11. Where applicable, the same numbers are used therein as were previously used with reference to the dinky press of FIGURES 1-5. Only one press cylinder 44 is shown as the other is identical.

The intensifier cylinder 38 is attached to the crosshead 16 which is connected, as before, to the moving platen. The main steam cylinder and the press cylinder 44 are connected to the frame 14 and fixed platen.

The intensifier cylinder 38 is hydraulically connected by line 100 to the valve 102. The reservoir 68 (which is here shown within crosshead 16) is hydraulically connected to the valve 102 by line 104. The upper part of the press cylinder 44 is connected through the piston rod 50 (which contains two independent conduits) to valve 102 by the line 106. The lower part of the press cylinder 44 is connected through piston rod 50 to valve 102 by line 103. The valve 102, in conventional hydraulic terms, is a 4-way 5-position operating valve. This valve 102 may be a single specially manufactured valve, or a number of independently operated conventional valves, or a combination of both. The valve 102 may be operated electrically, mechanically, hydraulically, or manually in any conventional manner, to provide automatic, semi-automatic, or manual control. The object of any programming method is merely the interconnection of various lines at the proper point as indicated by either pressure, position, or a combination thereof. Since the operation and construction of such valves are well known in the art, no further explanation is deemed necessary or appropriate. The operation of valve 102 will be explained merely by the interconnection of the various hydraulic lines.

The effective piston face areas are constructed so that the effective piston area A_1 of the lower part of press cylinder 44 is larger than that of the intensifier cylinder 38, and in turn the effective piston area A_2 of the intensifier is larger than that of the effective piston area A_3 of the upper part of press cylinder 44. For a specific example, assume that $A_1 - A_3 = 2A_2$ and that $A_3 = \frac{2}{3}A_2$.

To provide for rapid platen closure, at relatively low power and thus to effect the first step in compression, reference is now made to FIGURE 8. By proper manipulation of the valve 102, line 100 is hydraulically connected to line 106, thereby interconnecting intensifier cylinder 38 with the upper part of press cylinder 44, or said another way, interconnecting A_2 and A_3 . At the same time, the lower part of cylinder 44, that is A_1 is hydraulically connected to the reservoir 68, by interconnecting lines 103 and 104. Thereupon, upward movement of the main steam piston pushes the rod 34 and intensifier piston 36 upward. Just as was described with reference to FIGURE 3 previously, since A_2 is greater than A_3 and since intensifier cylinder 38 is con-

nected mechanically to press piston 46, hydraulic fluid flows into intensifier cylinder 38 from the upper part of cylinder 44 and not vice versa. As the piston 46 moves upwardly, fluid is merely sucked from the reservoir 68 into the lower part of cylinder 44. Now, since in this example $3A_3 = 2A_2$, for every upward unit of movement of the intensifier piston 36, the crosshead 16 moves upward three units. Said another way, the mechanical advantage is $\frac{1}{3}$. Therefore it is seen that platens close rapidly. It is further seen that the top of the intensifier piston 36 moves slower than the top of intensifier cylinder 38, hence instead of intensifier piston 36 moving into intensifier cylinder 38 it actually moves out. This then is the subtractive intensifier stroke previously mentioned.

After the first step has been completed and prior to the platens stalling due to the low power applied to the load, the hydraulic circuitry is reconnected in a different manner. Referring now to FIGURE 9, valve 102 is manipulated so that lines 106, 103 and 104 are hydraulically connected, which results in interconnecting the upper and lower parts of cylinder 44 and the reservoir 68, that is A_1 and A_3 are connected to the reservoir 68. At the same time, line 100 is blocked, so that fluid may not flow with reference to the intensifier cylinder 38 or A_2 . This is the same as mechanically connecting the main piston rod 34 to the crosshead 16 and moving platen. Therefore the mechanical advantage is 1. Hence every upward unit of movement of the intensifier piston 36 results in the same movement of the crosshead 16. In this second step then, the full power of the main steam cylinder is applied to the load between the platens. Now, the load may be compressed even further by changing the mechanical advantage to the circuitry shown in FIGURE 10, to which reference is now made. Valve 102 is manipulated so that lines 100, 106 and 103 are hydraulically connected. This results in interconnecting A_1 , A_2 and A_3 , or the intensifier cylinder 38 and the upper and lower parts of cylinder 44. The line 104 is blocked, thereby preventing access to the reservoir. In this situation, when the intensifier piston 36 is pushed upwardly, hydraulic fluid flows into the lower part of press cylinder 44 from the intensifier cylinder 38 and also from the upper part of the press cylinder 44, since A_1 is greater than A_3 . Therefore the intensifier piston 36 moves into the intensifier cylinder 38 even though the crosshead 16 also moves upwardly because of the increase in volume in the lower part of press cylinder 44. Since in our example $A_1 - A_3 = 2A_2$, for each upward unit of movement of the intensifier piston 36, the crosshead 16 moves up $\frac{1}{3}$ unit and the mechanical advantage is three. The moving platen thus closes more slowly with greater power. The total force applied to the load is the sum of the forces of A_2 and $A_1 - A_3$, which is greater than that supplied by the main steam piston alone. Hence, the force supplied to the load is increased over that supplied by the main steam cylinder with the increase being supplied by the hydraulic press cylinders.

Still a further step of compression is possible by again changing the mechanical advantage. Referring now to FIGURES 11, valve 102 is manipulated so that line 100 connects to line 103, while line 106 connects to line 104. Thus the intensifier cylinder 38 is interconnected with the lower part of press cylinder 44, or A_2 with A_1 . And the upper part of press cylinder 44 is connected to the reservoir 68, or A_3 with the reservoir 68. In this situation, when the intensifier piston 36 is pushed upwardly by the main steam cylinder, hydraulic fluid flows from the intensifier cylinder 38 to the lower part of press cylinder 44, which in turn moves the crosshead 16 upwardly. Hydraulic fluid in the upper part of the press cylinder 44 is merely dumped into the reservoir. Since A_1 represents a further increase in area over A_2 for the pressure developed in the intensifier to act on, the mechanical advan-

tage is again increased, resulting in more force being applied to the moving platen and load.

To open the press after compression, the valve 102 is manipulated so that all of the hydraulic lines 100, 106, and 108 are connected to line 104 and the reservoir. Therefore, in a manner similar to that described with reference to FIGURE 5, the weight of the moving platen parts returns the press to the starting position. This may also be accomplished in any other conventional manner.

Since the first step in utilizing the present invention results in a subtractive stroke of the intensifier piston 36, it is apparent that pressing operation may be begun with the intensifier piston well into the intensifier cylinder 38. As this first step is completed the intensifier piston 36 is drawn out from the faster moving intensifier cylinder 38. Thereupon in step two, the intensifier piston 36 and cylinder are effectively locked, and in steps three and four the piston 36 moves into the cylinder 38. Hence the total length of the intensifier cylinder 38 does not need to be as long as the main steam cylinder.

In a manner similar to the above four steps, if the intensifier is made double acting even more steps may be utilized.

In the claims which follow, reference is made to a main steam cylinder. It is to be understood that in utilizing the present invention this main force may be supplied by means other than a cylinder. That is, a force need only be supplied a direction to move the platens together and tending to push the intensifier piston within its cylinder. It should also be realized that the platens may be horizontally spaced or vertically spaced.

The present invention, therefore, is well adapted to carry out the objects and attain the ends and advantages mentioned as well as others inherent therein. While presently preferred embodiments of the invention are given for the purpose of disclosure, numerous changes in the details of construction and the combination, shape, size and arrangement of parts may be resorted to without departing from the spirit and scope of the invention as hereinafter claimed.

What is claimed is:

1. In a hydraulic press having power means, a fixed platen and a moveable platen, a first cylinder, a first piston operatively connected to said power means and moveable in said first cylinder, said first cylinder fixedly attached to and movable with said moveable platen, a second cylinder connected to the fixed platen, a second piston moveable in said second cylinder, said second piston mechanically connected to said moveable platen, said second piston having a smaller effective area than said first piston, and fluid conduit means for hydraulically connecting between the first cylinder and the side of the second cylinder having said smaller effective area, whereby the platens close rapidly upon actuation of the power means.

2. In a hydraulic press having power means, a fixed platen and a moveable platen, a first cylinder, a first piston operatively connected to said power means and moveable in said first cylinder, said first cylinder fixedly attached to and movable with said moveable platen, a second double-acting cylinder connected to the fixed platen, a second piston moveable within said second cylinder, said second piston mechanically connected to said moveable platen, said second cylinder mechanically connected to said fixed platen, one side of said second piston in said second double-acting cylinder having a smaller effective area than the effective area of said first piston, and means for hydraulically interconnecting alternatively said first cylinder with said side of said second cylinder having a smaller effective area, with both sides of said second cylinder, and with the other side of said second cylinder.

3. In a hydraulic press having a fixed platen, a moveable platen, and a main steam cylinder and piston, the improvement comprising an intensifier cylinder mechanically connected to said moveable platen, an intensifier

piston moveable within said intensifier cylinder and mechanically connected to said main steam piston, said intensifier piston having effective face area A_2 , at least one double-acting hydraulic power cylinder mechanically connected to said fixed platen, a power piston mechanically connected to the moveable platen and moveable within said power cylinder, said power piston having effective piston face areas A_1 and A_3 , face A_7 adapted to close said platens when hydraulic pressure is applied thereto, pressure is applied thereto, face area A_1 being greater than A_3 , the face area A_2 being greater than face area A_3 , and means to hydraulically connect faces A_2 and A_3 ; A_1 and A_3 ; A_1 , A_2 , and A_3 ; and A_1 and A_2 .

4. In a hydraulic intensified press of the type having a reciprocating power means, a fixed platen, and a moveable platen, the improvement including reciprocating hydraulic means having face A_2 mechanically connected between said power means and said moveable platen, reciprocating hydraulic means having faces A_1 and A_3 mechanically connected between said fixed and said moveable platens, the effective hydraulic area of means A_1 being greater than that of A_2 which is greater than that of A_3 , means A_1 arranged to close said platens when means A_2 is energized, means A_3 arranged to open said platens when means A_2 is energized, and valve means alternatively hydraulically connecting said means A_2 and A_3 , said means A_1 and A_2 , said means A_1 and A_3 , and said means A_1 , A_2 , and A_3 , thereby alternately subtracting or adding mechanical advantage to said press.

5. The invention of claim 4 including a reservoir hydraulically connected to said means A_1 when means A_2 and A_3 are hydraulically connected, to said means A_1 and A_3 when means A_1 and A_3 are hydraulically connected, and to said means A_3 when said means A_1 and A_2 are hydraulically connected.

6. The invention of claim 4 wherein reciprocating hydraulic means A_1 and A_3 comprise a double-acting cylinder and piston.

7. The invention of claim 6 wherein reciprocating hydraulic means A_2 comprises a single-acting cylinder and piston.

8. In a hydraulic intensified press of the type having a reciprocating power means, a fixed platen, and a moveable platen, the improvement including a first double-acting cylinder mechanically connected to the fixed platen, a second single-acting cylinder mechanically connected to the moveable platen, a first piston within said first cylinder mechanically connected to the moveable platen, said first piston having effective face areas A_1 and A_3 , face A_1 adapted to close said platens when hydraulic pressure is applied thereto, face A_3 adapted to open said platens when hydraulic pressure is applied thereto, a second piston within said second cylinder mechanically connected to said reciprocating power means and having effective face area A_2 , said piston face areas being in the relationship of $A_1 > A_2 > A_3$, and means alternately hydraulically connecting faces A_2 and A_3 , faces A_1 and A_2 , faces A_1 and A_3 and faces A_1 , A_2 , and A_3 .

9. The invention of claim 8 including a reservoir hydraulically connected to face A_1 when faces A_2 and A_3 are connected to faces A_1 and A_3 when faces A_1 and A_3 are connected, and to face A_3 when faces A_1 and A_2 are connected.

10. In a hydraulic booster to increase the stroke and capacity of a dinky press of the type having a fixed platen mounted on a frame, an upwardly closing platen under the fixed platen, suspended from a crosshead above the frame, and reciprocating power means including a connecting rod; the booster including a first double-acting cylinder mounted on the frame, a second single-acting cylinder mounted on the crosshead, a first piston within said first cylinder, a hollow connecting rod attached to said first piston and to said crosshead, said first piston having a first face adjacent said frame and a second face adjacent said crosshead, a second piston within said sec-

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ond cylinder attached to said power means connecting rod, said second piston having a face adjacent said cross-head, said pistons having effective face areas in the relationship of the first piston first face greater than the second piston face which is greater than the first piston second face, said hollow connecting rod communicating with the second face of said first piston, a first hydraulic line connecting said hollow connecting rod with said second cylinder, a check valve connected between the first and second faces and of said first piston adapted to pass a fluid from the first face to the second face, a fluid reservoir adjacent said press, a 3-position valve, a second hydraulic line connecting the upper part of said first cylinder with said valve, a third hydraulic line connecting the lower part of said first cylinder with said valve, a fourth hydraulic line connecting said reservoir with said valve, said 3-position valve having passageways connecting said third line with said fourth line in a first position for rapid

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closure of said platens when said power means connecting rod is energized, connecting said second line with said third line in a second position for slower, powerful closure of said platens, and connecting said second line with said fourth line in a third position for opening said platens.

11. The invention of claim 10 wherein said first hydraulic line is rigid.

References Cited in the file of this patent

UNITED STATES PATENTS

898,365	Holmes -----	Sept. 8, 1908
1,054,194	Gerdau -----	Feb. 25, 1913
1,930,155	Wiedmann -----	Oct. 10, 1933
2,220,798	Dinzl -----	Nov. 5, 1940
2,357,019	Nowak -----	Aug. 29, 1944
2,622,397	Nowak -----	Dec. 23, 1952
2,827,766	Hufford -----	Mar. 25, 1958
2,980,013	Swick et al. -----	Apr. 18, 1961

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,122,092

February 25, 1964

Stuart W. Sinclair

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 12, line 8, for "A₇" read -- A₁ --; line 10, before "pressure" insert -- face A₃ adapted to open said platens when hydraulic --; column 13, line 10, strike out "and", second occurrence.

Signed and sealed this 17th day of November 1964.

(SEAL)

Attest:

ERNEST W. SWIDER
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents