Dec. 5, 1939. E. D. EBY ET AL 2,182,663

HYDRAULIC PRESS FOR ELECTRIC CABLES AND METHOD OF UTILIZING THE SAME

Filed Feb. 19, 1938 2 Sheets-Sheet 1

Fig. 1.

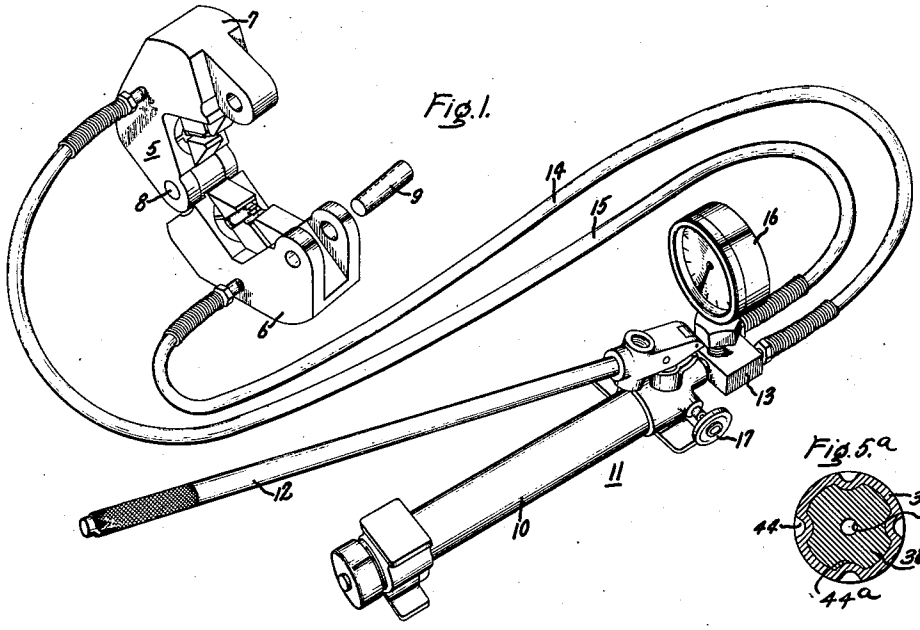


Fig. 5.a



Fig. 2.

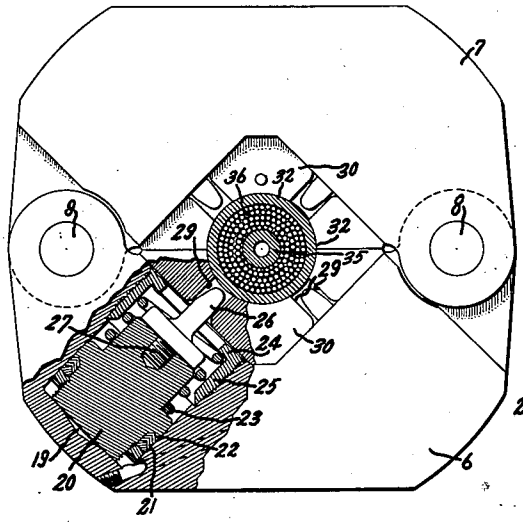


Fig. 3

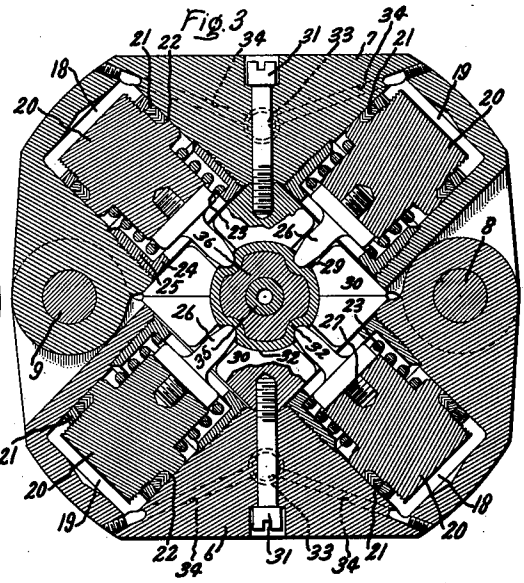
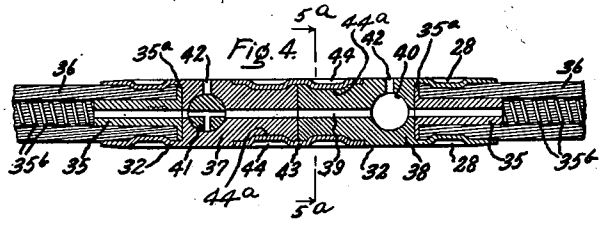


Fig. 4.



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HYDRAULIC PRESS FOR ELECTRIC CABLES AND METHOD OF UTILIZING THE SAME

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Fig. 5

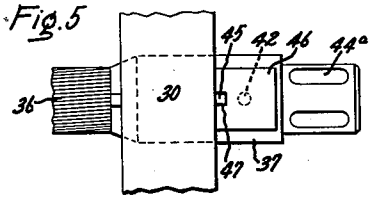



Fig. 7.

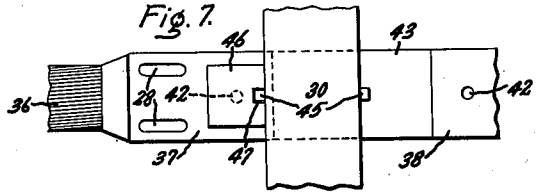



Fig. 6.

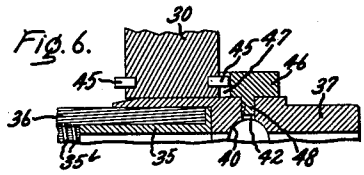



Fig. 8

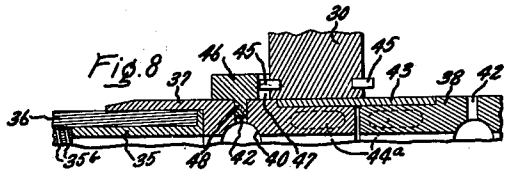



Fig. 9.

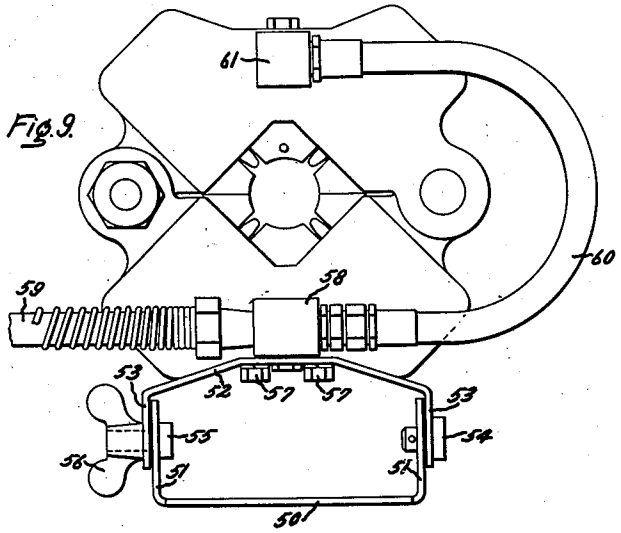
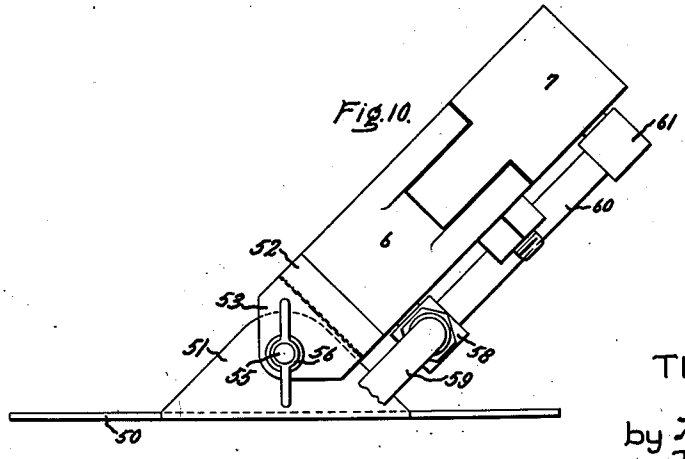



Fig. 10.




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2,182,663

# UNITED STATES PATENT OFFICE

2,182,663

## HYDRAULIC PRESS FOR ELECTRIC CABLES AND METHOD OF UTILIZING THE SAME

Eugene D. Eby and Thomas C. Aitchison, Pittsfield, Mass., assignors to General Electric Company, a corporation of New York

Application February 19, 1938, Serial No. 191,556

13 Claims. (Cl. 140—113)

In installations of electric cables, it is necessary electrically to connect the conductor lengths to form a continuous circuit. In the majority of cases, this has been done by means of connectors which are soldered to the ends of adjacent lengths. There are, however, cases where the application of heat, as in soldering operations, is highly objectionable on account of the nature of the material used to impregnate the conductor insulation. As an alternative, it has been proposed to squeeze or compress the connector as a whole by hydraulic action about the ends of the conductors. Such action naturally requires a very large amount of power. Where the cables are laid in trenches, this is a comparatively simple matter because large presses can be used without special difficulty but such presses cannot as a rule be lowered into manholes for use in splicing underground cables. In fact, in most cases, on account of the reduced diameter of the manhole opening, such presses due to their size and weight cannot be used.

Our invention has for its object the provision of an improved hydraulic press for jointing cables which is sufficiently powerful to indent the metal of the connector at spaced intervals into firm electrical engagement with the strands of the conductors and which at the same time is small enough and light enough to be lowered through the manhole and to be readily handled thereafter in making joints.

For a consideration of what we believe to be novel and our invention, attention is directed to the accompanying description and the claims appended thereto.

In the accompanying drawings which is illustrative of our invention, Fig. 1 is a perspective view of our improved press together with the pump for producing the necessary hydraulic pressure; Fig. 2 is an end view, partly in section of the press; Fig. 3 is a cross sectional view of the press; and Fig. 4 is a longitudinal section of a connector for hollow core fluid filled cable; Fig. 5[a] is a cross-sectional view taken on line 5[a]—5[a] of Fig. 4; Figs. 5 to 8 are views illustrating means whereby the press may be accurately positioned with respect to the connector parts; Fig. 9 is a view illustrating the press and a support therefor; and Fig. 10 is a view in elevation showing the press carried by the support and inclined at an angle thereto.

5 indicates the press which is made of two principal frame parts 6 and 7, the parts being united by a cylindrical hinge pin 8. A second and removable pin 9 or equivalent device is provided to unite the parts when they are in position surrounding the connector preparatory to pressing operation. The pin is slightly tapered to facilitate its removal when it is desired to open the press. The cooperating surfaces of the meeting parts of the press frame are nicely fitted and are relatively wide and substantial so as to ensure proper alignment when closed about a cable connector. 10 indicates the barrel or liquid containing member of an hydraulic pump 11 and 12 is the hand operating lever thereof. Liquid is delivered by the pump to the manifold 13 and from it to the press through flexible conduits 14 and 15, the former being connected to the lower half of the press and the latter to the upper half. For some purposes a single pipe suitably connected to both halves of the press will be sufficient. A suitable pressure gauge 16 is attached to the manifold so that the operator can see what pressure is being created by the pump. A valve controlled by the handle 17 is employed to release the pressure within the manifold press and connected parts when it is desired to release the rams preparatory to removing the press. While the pump illustrated is well adapted to supply liquid to the press other forms of pumps may be used, provided they are capable of delivering liquid at the desired pressure. The press shown is capable of exerting pressures of the order of twenty tons per punch and hence the pump, conduits and other parts should be capable of withstanding such pressure. The details of the pump form no part of the present invention.

As before stated, the press is made of two principal parts 6 and 7 forming the frame and which are united by pins. The press is made in this manner so that it may completely surround the connector which is to be attached to the end of a cable conductor, and so that it can readily be removed when the work is completed. Each half of the press frame has two cylinders 18 and 19 which open toward the center axis of the press and cable. Inside of each cylinder is a ram 20 that is guided in its reciprocating movements by the cylinder wall. It is also provided with suitable packings 21 which rest in a V-shaped groove in a shoulder 22 of the ram. On the opposite side of the shoulder is located a strong compression spring 23 for retracting the ram when the hydraulic pressure is released. The springs also act to force the liquid employed to actuate the rams from the cylinder spaces, conduits and manifold back into the barrel or liquid container 11. Each spring 23 is seated at its inner end on a flange 24 of a tubular bushing 25 which

is screw threaded into the lower end of a ram-containing cylinder. Each ram is provided with a detachable punch **26** having a large flat head which rests squarely on the inner face of the ram. It is held in place by a screw threaded stud **27** entering the body of the ram. The punches are made detachable so that others may be quickly substituted when the press is to be used with connectors of different diameter, or thickness of wall, or both. Similarly, the guide blocks are removable and for the same reason. Each punch has a rounded end, converging sides and sufficient axial length to form a suitable indentation, such as **28**, Fig. 4, when the rams are forced inwardly. The shape of the punch facilitates its retraction after the pressure is released. Each punch is guided in its movements by guiding surfaces **29**. The guides for each two punches are formed in the same block **30**, each of the blocks having flat faces that rest squarely upon and are supported by the frame member adjacent the cylinder ends. The block is held in position by the screw **31** which, however, does not have to carry any appreciable load. The two guide blocks when assembled about the connector **32** define a cylindrical central opening the wall or surface of which engages the connector and prevents it from enlarging in diameter when the punches are moved inwardly. In other words, the guide blocks considered as a unit hold the connector to its initial cylindrical shape. Fig. 2 shows the relation of parts before the press acts, and Fig. 3 afterwards. The outer surfaces of each guide block are in 90 degree relationship and fit into a correspondingly shaped recess. The adjacent surfaces of the blocks are smooth and flat and located in the horizontal diametral plane of the cable. As a result, not only are the blocks firmly anchored but they have no opportunity to turn or twist. It will also be seen that the function of the screws **31** is to prevent the blocks from being displaced and not to carry any appreciable load. In each half of the frame is a port **33** which is connected to one of the fluid pressure conduits. Extending from the port are passages or channels **34**, one leading to each of the cylinders. This ensures equal pressures on the rams.

When the press is used with cables having hollow cores, with strands supported on coil springs **35***b*, a strong steel tube **35** is slipped endwise into each of the conductors, the purpose being to prevent the stranded electrical conductor **36** from collapsing when external pressure is applied. Each steel tube has a collar or flange **35***a* formed integrally therewith, the purpose of which is to accurately locate the tube within the core of the cable, and specifically to prevent the tube from being pushed too far in the core of the cable or slipping downwardly into the core when the end of a cable is elevated or inclined as it is preparatory to applying a half connector. In Fig. 3, the punches are shown as having moved inwardly and in so doing have made indentations, such as **28**, in the wall of the connector. No attempt has been made in this figure to show the shape of the individual strands of the conductor because the compacting causes them largely to flow together and to more or less have the appearance of a solid conductor.

It is evident that if pressures of the order of twenty tons per punch are used, as in the present case, without suitable backing the connector would be badly distorted as would also the conductors. We avoid this by using four radially disposed punches spaced 90° apart with guide blocks enclosing and confining the connector except in line with the punches and operating the punches simultaneously, thus imparting to each substantially the same force. Due to this arrangement, the pressure due to one punch is balanced by that of the punch diametrically opposite it. From this, it follows that since the punches move radially inward and since the forces exerted are balanced no stresses are imparted to the cables tending to injure them when the press is in use. When the guide blocks are assembled, as best shown in Fig. 3, they form a square and the outward pressures thereon due to the action of the punches on the connector are taken by the solidly built frame members **6** and **7**. The pins **8** and **9** are sufficiently strong to prevent any separation of the frame parts when the punches are in action. After the fluid pressure is removed and the rams are retracted by the compression springs, the press as a whole may be adjusted longitudinally of the connector preparatory to further punch operations. With the pressure removed, it is a simple matter to drive out the tapered pin **9** and open the press.

In Fig. 4 is shown a connector comprising two similar parts **37** and **38**, each having a passage **39** communicating with the channels in the cores of the conductors. Each half connector has a slightly tapered valve seat **40** for the reception of a plug valve **41** whereby the outward flow of liquid from the cable may be controlled as well as the flow from cable to cable. Extending outwardly from the seat and valve is a port **42** whereby a controlled amount of liquid from the cable may be discharged to remove foreign matter.

Each half connector has an internally formed socket to receive an end of a stranded conductor **36**, and a hollow cylindrical part which is of relatively thick metal in which are preformed longitudinally extending shallow grooves **44**[a] spaced 90° apart. The halves of the connector are enclosed in a sleeve **43**, Fig. 4, having relatively thin walls, portions of which are subsequently forced inwardly into the grooves to form indentations **44**. When so forced, the metal of the sleeve **43** firmly unites the halves of the connector and thus a through confining passage for the impregnating liquid of the cable is established.

It is important that the pressures applied by the press shall not distort the metal of the connector in the region of the valve seat **40** because such distortion would result in the failure of the valve to seat properly. This means that the location of the indentations with respect to the valve seat becomes an important factor in securing the best results. For this purpose, a pair of pins or equivalent devices **45**, Fig. 5 are mounted on opposite sides of the upper half of the guide block **30**. On the connector is detachably mounted a locating block **46**. The side of the locating block presented to the press is provided with a notch **47** with which a pin **45** on the guide block **30** is adapted to engage. In order that the locating block may be accurately positioned, it is provided on its under side with a small pin **48** which fits into the port **42**. As shown in Figs. 5 and 6, the locating block **46** has its notch **47** facing the left with its pin **48** in the fluid escape port **42** and a pin **45** on the guide block entering it. By this simple arrangement of parts, the press may be accurately positioned in an axial direction, and because of the location of the pin **45** in the notch, it is angularly positioned as well.

Because one end of each connector is made

of relatively thick metal and has preformed grooves designed to receive the metal of the sleeve **43**, it follows that the press must be so angularly positioned around the connector that the punches will be in radial alignment with the grooves. This is done by reversing the position of the locating block as shown in Figs. 7 and 8 with the result that the depressions or indentations in the sleeve caused by the punches will register with the grooves **44a** and fit tightly therein.

In Fig. 9 an arrangement of parts is shown such that, for the sake of simplicity, one pipe from the pump may be used instead of two as shown in Fig. 1. The fitting **58** receives a flexible pipe **59** leading from the pump and a second flexible pipe **60** leading to a fitting **61** on the upper half of the press, the two pipes being in series. The pipe **60** is purposely made relatively long with a generous bend to avoid damage and to permit the press to be opened and closed after the tapered pin **9** is driven out.

Desirably in applying the half connectors, the ends of the cable are upturned to form traps to prevent the admission of air and other foreign matter. Under these conditions, it is desirable to support the press by suitable means so as not to stress the cable. In Fig. 9 is shown a support suitable for the purpose. It comprises a flat base member **50** having a pair of upturned ears **51** located on opposite sides thereof. Above the base is a member **52** having downwardly extending ears **53**. The ears are united on the one side by a pivot pin **54** and on the other side by a pin **55** having its outer end screw threaded to receive a wing nut **56**. The upper member **52** is firmly attached to the press, as for example, by stud bolts **57** which are seated in the lower half of the press **6**. In Fig. 10, the press is shown supported at the proper angle to receive the upwardly inclined end of a cable preparatory to applying a half connector. When the press is used to secure the uniting sleeve **43** over the adjacent ends of the half connectors, the press will stand vertically with the base member **50** at right angles thereto.

Assuming that a half connector is to be applied to a cable end which is inclined upwardly the press is placed on a suitable support, such as is shown in Figs. 9 and 10, with the axis of the press coinciding with the axis of the upturned cable end. A small piece of the spiral spring **35b**, Fig. 4 is pulled out and cut off, then the steel tube **35** is pushed into the core of the cable until the collar on the end is in firm contact with the ends of the strands. The connector half is then slipped over the end of the conductor and both are located in approximate positions in the lower half of the press. Next, the exact position of the connector in the punch guide block is secured by the locating block. Sufficient pressure is then applied to the punches to hold the connector in its position. The end of the conductor is then forced into place to fully seat it after which the final pressure is applied to the punches by means of the rams. When this operation is completed, the pressure on the rams is released by opening the valve **17** at the pump and the springs **23** will withdraw the punches. Care should be taken to see that the working ends of the punches are cleaned and well oiled. The end of the other cable to be jointed is similarly treated.

After the cable ends have each been provided with a half connector, the cables are trained into final alignment. The sleeve **43** is then slipped into place over the tubular end of one of the connectors. The connector and sleeve are next located in their approximate positions in the lower half of the press and later moved to exact longitudinal and angular positions, using for the purpose the locating block. The punches are then caused to be moved inwardly by a sufficient amount to hold the parts in position and later the final pressure is applied to make the indentations and then released. After the second half connector is seated in the sleeve **43**, the press is opened and moved over that portion of the sleeve enclosing the second connector half, next the press is closed and the above described operations repeated.

In rare cases, it becomes necessary to remove a connector. It is important that this be done without injuring the cables since in some cases there may not be enough slack in a manhole to permit of cutting off any part thereof. One of the advantageous features of the longitudinal indentations located 90 degrees apart is that the connector can be removed and a new one substituted. This can be done by sawing through the connector in a plane at right angles to the axis of the cable and in a plane registering with the end of the conductor strands. This leaves a part of the connector in the form of a ferrule attached to the strands by four indentations. Between the indentations, the ferrule is not deformed as indicated in Fig. 3 and at these points can be sawed through in a plane in the axis of the cable. By making either two opposite saw cuts through the ferrule down to the strands, or four if desired, the ferrule may be split off or removed from the strands without damaging them. This leaves the strands in the form they assumed after the original connector was pressed into place. By binding the ends of the strands with a temporary clamp, a new half connector can be fitted over the strands and pushed on to the same position as the original connector. The press can then be applied and the indentations made in the new connector opposite the depressions in the strands so that the new connector occupies the same position as the original. From the foregoing, the importance of longitudinally extending depressions or indentations as distinguished from circumferential grooves becomes apparent for in the latter case the connector cannot readily be axially split and removed. The indentations are desirably relatively long compared to their width and are sufficiently deep to compact the strands in close contact with each other and the connector part, thereby firmly uniting the parts and establishing good electrical connection with the strands.

The division of the press frame into parts is desirable in all cases to facilitate the use of the press, and is necessary when a sleeve **43** is employed to unite the half connectors since otherwise the press could not be removed as it completely surrounds the cable connector.

The press has been described in connection with a cable joint but it can with advantage be used for connecting other conductors and specifically for connecting a cable end to a terminal stud.

Since the heads of the cylinders are integral with the frame members, all danger of leakage in these regions is avoided. Should the packing of a ram become worn, it can be replaced by first removing the adjacent guide block and then the tubular bushing **25**. After this is done, the ram and its punch can be removed giving full access to the packing.

Notwithstanding the very great pressures which can be exerted on the punches, in this case twenty tons, the complete press has a weight of the order of eighty pounds, and therefore presents no difficulty in handling even in the crowded space of an underground cable manhole.

The construction of the connector illustrated in Fig. 4 is not claimed herein, it being the sole invention of Eugene D. Eby.

What we claim as new and desire to obtain by Letters Patent of the United States is:

1. A press comprising separable frame members arranged to encircle a piece of work, means for converting the members when they encircle the work, cylinders formed in each of the members, each cylinder in one member being in the same diametral plane as a cylinder in another member, a ram for each cylinder, a punch for each ram, for indenting the work, a fixed guide block having radical openings for the punches and also a central work receiving opening, the wall of which limits the radial distortion of the work extending therethrough as the punches move inwardly, and means admitting fluid under pressure simultaneously to all of the cylinders to cause the rams to force the punches into the work and form indentations therein.

2. A press comprising a pair of frame members, means for uniting the members in a manner to define a work receiving opening, a pair of radially disposed cylinders formed in each of the members, a ram in each cylinder, a retractile means for each ram, a punch movable with each of the rams, a fixed guide having openings with radial walls for guiding the punches and a central opening through which the work extends, the wall of the central opening preserving the initial contour of the work when the punches enter it and form indentations, and means for supplying fluid under pressure to all of the cylinders for simultaneously moving the punches radially inward through the guide openings into engagement with the work to form indentations therein.

3. A press comprising a pair of frame members, a hinge connection between two of the adjacent ends of the frame, a locking connection between the other two ends, a pair of radially disposed cylinders formed in each of the members, a ram in each cylinder arranged to move in a radial plane with respect to the work, a retractile means for each ram, a punch attached to and movable with each ram, a guide block divided in a diametrical plane passing through the hinge connection which encloses the work and confines it against enlargement, the block having radial openings through which the punches extend to indent the work, and means for supplying fluid under pressure to all of the cylinders for simultaneously moving the punches radially inward through the openings into engagement with the work.

4. A press comprising a pair of detachably connected frame members defining a substantially square central opening, radially disposed cylinders in the members, a ram in each of the cylinders, a punch attached to each ram having definitely converging sides and a rounded end, a divided guide block, the outer walls of which fit the square central opening, having radial openings through which the punches extend and are guided by the walls thereof for engagement with the work, and means for supplying fluid pressure to all of the rams to cause simultaneous inward movement of the punches.

5. A press for cable connectors of tubular form in which the ends of stranded conductors are located, comprising detachably connected frame members, a pair of radially disposed cylinders in each of the members, a ram in each cylinder, means for simultaneously admitting fluid under pressure to the cylinders for moving the rams radially inward, a retractile spring in each cylinder for moving the rams outwardly away from the connector when the fluid presure is released, an abutment for each spring located in its corresponding cylinder, a relatively narrow punch moved inwardly by each of the rams to form a relatively long narrow indentation in the peripheral wall of the connector, and a divided guide block for the punches, the parts of the block being secured one to each half of the frame members and separable therewith, the block having radial openings for guiding the punches into the work, and a central opening, the wall of which preserves the initial contour of the work as the punches tend to distort it.

6. A press for cable connectors of tubular form in which the ends of stranded conductors are located, comprising detachably connected frame members, a pair of radially disposed cylinders in each of the members, a ram in each cylinder, means for simultaneously admitting fluid under pressure to the cylinders for moving the rams radially inward, a retractile spring in each cylinder for moving the rams outwardly away from the connector when the fluid pressure is released, an abutment for each spring located in its corresponding cylinder, a relatively narrow punch moved inwardly by each of the rams to form a relatively long narrow indentation in the peripheral wall of the connector, and a pair of guide blocks supported by the frame members, each block having guide surfaces for a pair of punches and outer surfaces extending at right angles to each other engaging the members and flat meeting faces, the blocks defining a central opening, the walls of which enclose the connector and prevent distortion thereof when the punches move inwardly to make indentations in the peripheral surface of the connector.

7. A press comprising frame members arranged to encircle a hollow piece of work connector, means permitting the members to be opened to encircle the work and thereafter be closed around it, a pair of radially disposed cylinders formed in each of the members, each cylinder in one member being diametrically aligned with a cylinder in another member, a ram for each cylinder, a punch actuated by each ram, a guide block having radial guiding surfaces for the punches and a central opening to receive the work, the wall of which limits the radial distortion of the work, a tube inside of the work for preventing the collapse thereof when the punches are forced inwardly, and means for admitting fluid under high pressure simultaneously to all of the cylinders to cause the rams to force the punches into the outer wall of the work to form radially displaced indentations therein.

8. A press comprising opposed separable frame members which when assembled define between them an opening having a non-circular wall, a hinge pin uniting the members on one side, releasable means for uniting the members on the opposite side, cylinders formed in each of the members, each cylinder in one member being in the same diametral plane as a cylinder in another member, a ram for each cylinder, a punch for each ram, a hollow guide block for the punches, the outer wall of which engages the

non-circular wall of the members and is held in fixed position thereby, the guide block having radial openings for the punches and a central work receiving opening, the wall thereof confining the work extending therethrough, and means admitting fluid pressure simultaneously to all of the cylinders to cause the rams and punches to move radially inward and form indentations in the work.

9. A portable press for indenting hollow articles, comprising detachably connected frame members encircling the work, diametrically opposed cylinders in the members, rams in the cylinders, punches actuated by the rams, radially disposed guide means for the punches, means for supplying fluid to all of the cylinders in a manner to cause simultaneous operation of the rams and punches, and means for definitely positioning the press in axial position on the article preparatory to operating it comprising a device attached to the press and a cooperating device supported by the article.

10. A press for indenting hollow articles, comprising detachably connected frame members, diametrically opposed cylinders in the members, rams in the cylinders, punches actuated by the rams, radially disposed guide means for the punches, means for supplying fluid to all of the cylinders in a manner to cause simultaneous operation of the rams and punches, and means for locating the press preparatory to operating it comprising a pin carried by the press and a block carried by the article, the block having a notch in one of its faces to receive the press pin, and a pin on the under side of the block which fits into the article.

11. A press comprising frame members arranged to encircle a piece of work, means permitting the members to be opened to encircle the work and thereafter be closed around it, cylinders formed in each of the members, each cylinder in one member being in the same diametral plane as a cylinder in another member, a ram for each cylinder, a punch for each ram, a guide block for the punches having a work receiving opening, the wall of which limits the radial distortion of the work extending therethrough, means admitting fluid under pressure simultaneously to all of the cylinders to cause the rams to force the punches into the work and form indentations therein, a support for the press having a flat base, an element secured to one of the frame members, and adjustable connecting means between the base and the element.

12. The method of applying a connector to a hollow core stranded cable which comprises inserting a metal tube inside of the core defined by the strands to prevent collapsing of the core when subjected to external pressure, inserting an end of the cable into a hollow metal connector, and simultaneously forcing a plurality of punches radially inward from opposite sides of the axis of the connector to form shallow axially extending indentations therein to unite the strands of the conductor and the metal of the connector.

13. A portable hydraulic press for indenting hollow cable connectors comprising hinged frame members, diametrically opposed radially disposed cylinders in the members, a ram in each cylinder, radially movable punches operated by the rams, a guide block through which the punches pass prior to indenting the connector, means for simultaneously supplying fluid under pressure to all of the cylinders to actuate the rams, and means for definitely positioning the press about the connector both axially and angularly preparatory to the pressing operation, one part of the means being on the press and movable therewith and another part definitely fixed as to its position by the connector.

EUGENE D. EBY.
THOMAS C. AITCHISON.

CERTIFICATE OF CORRECTION.

Patent No. 2,182,663. December 5, 1939.

EUGENE D. EBY, ET AL.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 4, first column, line 14, claim 1, for the word "converting" read connecting; line 20, for "radical" read radial; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 30th day of January, A. D. 1940.

(Seal)

Henry Van Arsdale,
Acting Commissioner of Patents.