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T. W. HOWLETT, JR., ET AL
APPARATUS FOR CONTOUR FORMING

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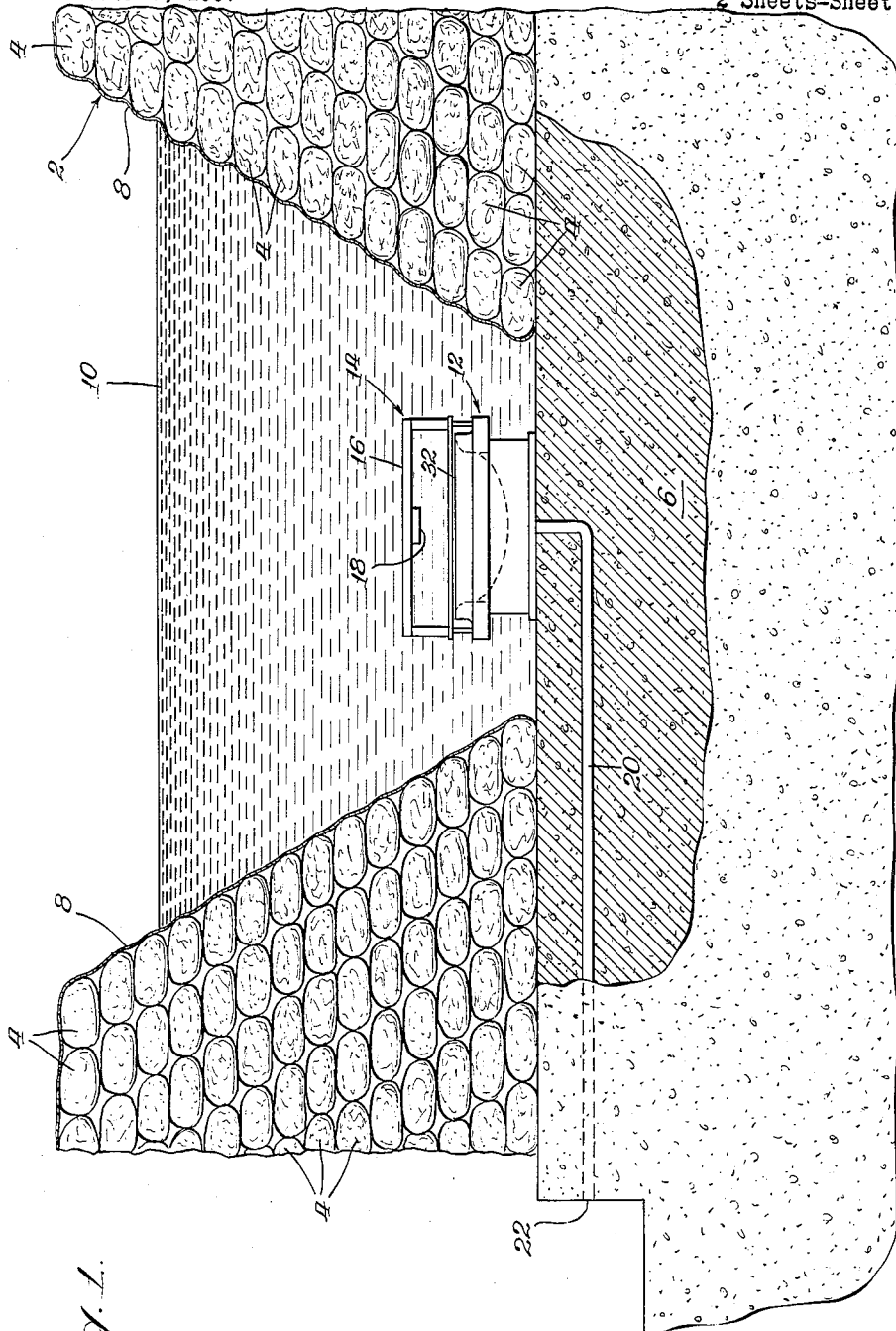


Fig. 1.

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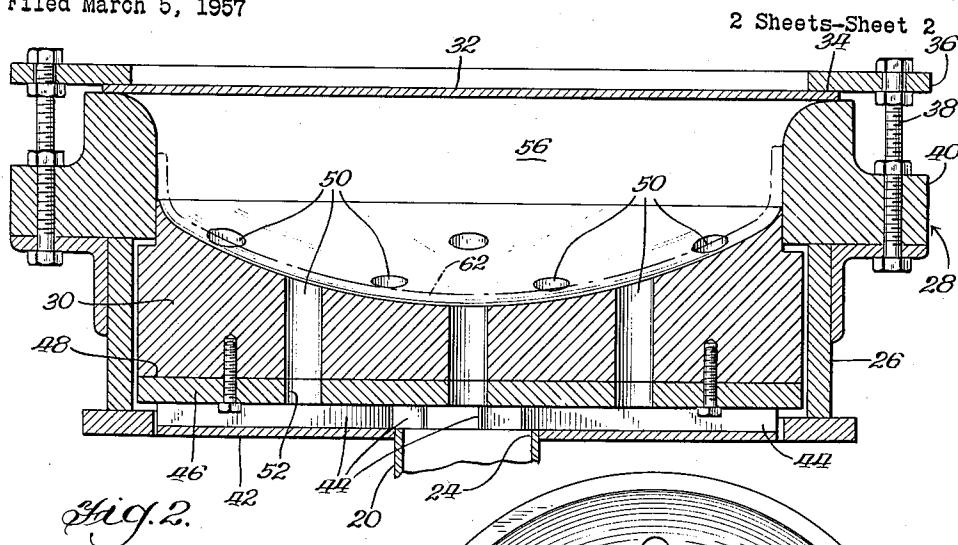
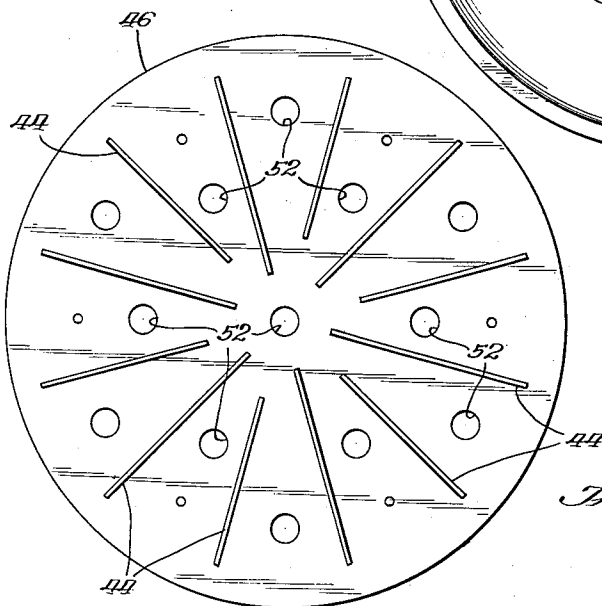
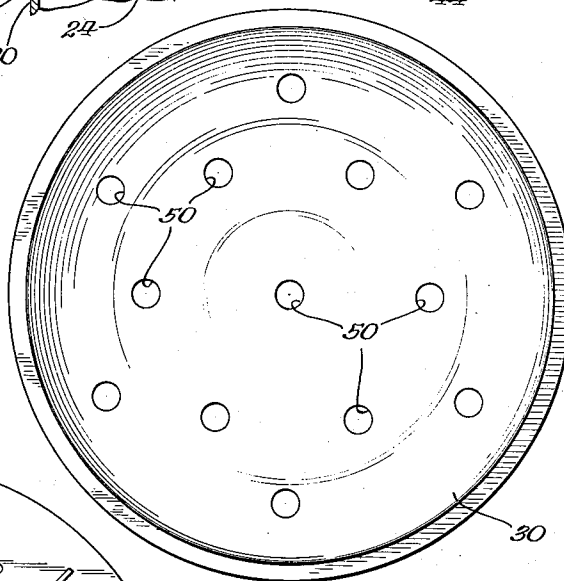


Fig. 3.



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APPARATUS FOR CONTOUR FORMING

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1 Claim. (Cl. 113—44)

The invention relates to a novel apparatus having particular utility in forming to desired contours various materials such as metallic plates.

In many industries, such as for example, the plate fabricating industry, it is frequently necessary to form materials into pre-determined contours. The particular shapes desired have presented the persons in the art with many problems from the standpoint of forming the material, especially in an economical and satisfactory manner. A typical illustration relates to manufacturer of tank equipment of various types of metals such as steel, aluminum, etc. The tanks may be of generally cylindrical form and provided with dished heads at opposite ends of the central cylinder. Little problem is encountered in forming the central cylindrical portion as a flat plate of desired material need merely be rolled into cylindrical form, thereafter having its abutting ends appropriately secured in any conventional manner such as by welding. More difficulty is presented in forming the dished or contoured heads to close the ends of the cylinder and here the conventional methods of die forming in a mechanical or hydraulic press or spin forming to contour have frequently been utilized to accomplish the desired end.

The economy of manufacture of these dished heads has been subject to frequent scrutiny because expensive die or mandrel equipment must be provided which becomes excessively costly from the standpoint of unit production where low volume head production is required. In point of fact, such low volume and high unit cost does occur frequently because tanks of this nature are fabricated to customers specifications which dictate variety in important details in most instances. To summarize, in such low volume production the high cost of die or mandrel equipment as well as the considerable expenditure in capital machinery such as presses or spinning machines has rendered such manufacture extremely expensive.

Accordingly, it is a primary object of the invention to provide an arrangement offering a comparatively inexpensive method and apparatus for forming to determined contours.

It is a further specific object of the invention to provide a novel physical arrangement which utilizes the force available as a result of detonation of high explosives to directly act upon and form metals to desired shapes.

Specifically, one embodiment of the invention contemplates the use, in combination, of a comparatively inexpensive die arrangement, a metallic plate to be formed, the adjacent location of a determined quantity of highly explosive material, a fluid ballast to accommodate reactive and conductive means for the explosive force, and a determined physical arrangement of the mentioned structure to utilize the force resulting from an explosion of the material to accommodate desired plate formation.

It has been found that this type of arrangement quickly and easily, for example, forms flat plate material into desired contours and has a particular advantage over earlier prior art methods in that the tendency to unde-

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sirably mar the surface of the material as the result of mechanical action thereon is greatly reduced.

The invention is best illustrated with reference to the following specification and to the associated drawings wherein:

Figure 1 is a partially schematic, sectional, side elevational view of a typical arrangement employed.

Figure 2 is a detailed vertical, half sectional view of a typical die arrangement employed,

Figure 3 is a detailed plan view of a section of the die illustrated in Figure 2, and

Figure 4 is a plan view of a baffle associated with the die arrangement of Figure 2.

Describing the invention in detail and directing attention to Figure 1, it will be seen that the invention comprises a vessel indicated generally at 2, said vessel being of any suitable configuration and for illustrative purposes is seen to comprise a plurality of sand bags 4 appropriately mounted on a concrete or firm foundation 6. A containing liner of flexible and liquid impervious material 8 is positioned over the sandbags 4 whereby the entire arrangement may accommodate a head of water 10 without leakage. Centrally of the vessel 2, a die arrangement, indicated generally at 12, may be located. A supporting bracket 14 having a center bar 16 is arranged above the die 12 to position and support an explosive charge 18 in determined relation to the die arrangement 12. A passage or line 20 may be provided in the concrete foundation 6 and establishes communication with the atmosphere as at 22 while having its other end communicating with the die arrangement 12 as at 24 (Figure 2).

Directing attention to Figure 2, it will be seen that the die arrangement 12 may comprise an annular supporting member 26 carrying, at the upper edge thereof, a piece supporting ring 28. Centrally of the arrangement 12 a die insert 30 is provided, said die insert preferably being of non-metallic material such as hardwood which is one of the economical features of the disclosed invention. A piece of rigid material such as a plate 32 may be positioned in engagement with the upper surface of the ring as at 34 prior to forming. A clamping member 36 is provided to engage the upper surface of the plate 32 adjacent its peripheral edge. A plurality of clamping bolts 38, extending between a peripheral ledge 40 and the plate 36, serve to fixedly maintain or clamp the plate 32 to the ring 28.

The pipe 20 is connected to and communicates with a base plate 42, said plate 42 engaging upstanding flanges 44 which in turn form part of a baffle plate 46, said baffle plate being arranged, in the illustrated embodiment, to engage the bottom surface of the insert 30 as at 48.

Briefly referring to Figures 3 and 4, it will be noted that the insert 30 and the baffle plate 46 are provided with a plurality of apertures 50 and 52 respectively. In the assembled condition the apertures 52 of the baffle plate are preferably arranged to register with the apertures of the insert 30, the purpose of which will hereinafter be explained in detail. Suffice it now to say that the apertures 50 communicate with the die cavity 56 defined by the upper surface of the insert 30 and the lower surface of the mounted plate 32. This arrangement in combination with the upstanding flange construction of the baffle plate 46 thus establishes a line of communication between the die cavity 56 and the atmosphere via pipe 20.

In an illustrative operation of the herein disclosed method and apparatus, it will be noted that the die arrangement 12 may be positioned in the containing vessel 2 so that the mentioned communication is established between the cavity 56 and the atmosphere. Thereafter, a plate 32 may be positioned on the ring member 28 and

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clamped thereto so as to be in substantial sealing engagement with the die arrangement 12. If desired, the ring 28, the plate 32, and/or the clamping member 36 may be lubricated with a suitable grease or the like so as to assure a substantially liquid tight connection between the parts mentioned. Thereafter, a head of liquid 10 is provided in the vessel 2 so that the explosive charge 18 as well as the upper surface of the plate 32 are immersed therein. It will be noted that because of the fact the plate 32 is in liquid tight engagement with the die 12 that an arrangement has been provided wherein fluids of substantially different density are provided on opposite sides of the plate 32, namely, water on the upper surface of the die and air in the cavity 56.

Of course, it will be understood by those skilled in the art, that the explosive charge 18 is connected to suitable detonating equipment (not shown). The high explosive charge 18 may then be detonated and the explosive force thereof is transmitted downwardly through the surrounding water 10 and impinges itself on the upper surface of the plate 32 forcing the latter downwardly into the die arrangement 12 and particularly into intimate contact therewith as is illustrated in phantom lines at 62 in Figure 2.

The presence of the less dense fluid or air in the cavity 56 coupled with the communication established between said cavity and the atmosphere readily accommodates the evacuation of said less dense fluid substantially simultaneously with the detonation of the charge 18 thereby allowing forcible movement of the plate 32 into intimate contact with the die member 12.

It will be noted that in the illustrative embodiment, the explosive charge 18 is positioned centrally above the plate 32 and die arrangement 12. The exact location of the explosive charge as well as the depth of the water or liquid head 10 will vary depending upon the type of material used and the configuration of the product to be formed. Also, in some instances, it may be desirable to form the particular material in stages with a plurality of explosive forming steps in sequence.

Another advantage to the method and apparatus disclosed relates to the condition of the plate 32. The action herein described does not severely mar or indent the surface of the plate 32, as has frequently been the case in more conventional methods of forming such as on press equipment or spin forming to a mandrel. It has also been found that the method and apparatus here described has particular utility in forming die heads of

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various contours in low quantity production set ups in view of the fact that the explosive charge utilized is relatively cheap and that die inserts may be made of relatively cheap and easily formed non-metallic material such as hardwood thereby considerably reducing the cost of low quantity production items. Further, the investment in capital equipment is substantially reduced as compared to the prior methods of forming heretofore considered.

The invention as shown is by way of illustration and not limitation and may be subject to various modifications without departing from the spirit thereof or the scope of the appended claim.

What is claimed is:

In an apparatus of the type including a vessel containing a liquid, an energy producing device located in the liquid for forming a normally rigid material, supporting means for said rigid material, die means spaced from said rigid material and including means defining a plurality of openings extending between opposite sides of the die means, baffle plate means detachably secured to the side of said die means remote from the rigid material and including means defining a plurality of openings in registry with said die means openings, passage means establishing communication between a point in the bottom of the vessel and the atmosphere, and said plate means including a plurality of baffles extending radially of said point and a central area of the die means and in engagement with the bottom of said vessel to provide communication between said registered opening means and said passage means to facilitate evacuation of air between the rigid material and the die means during a forming operation.

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