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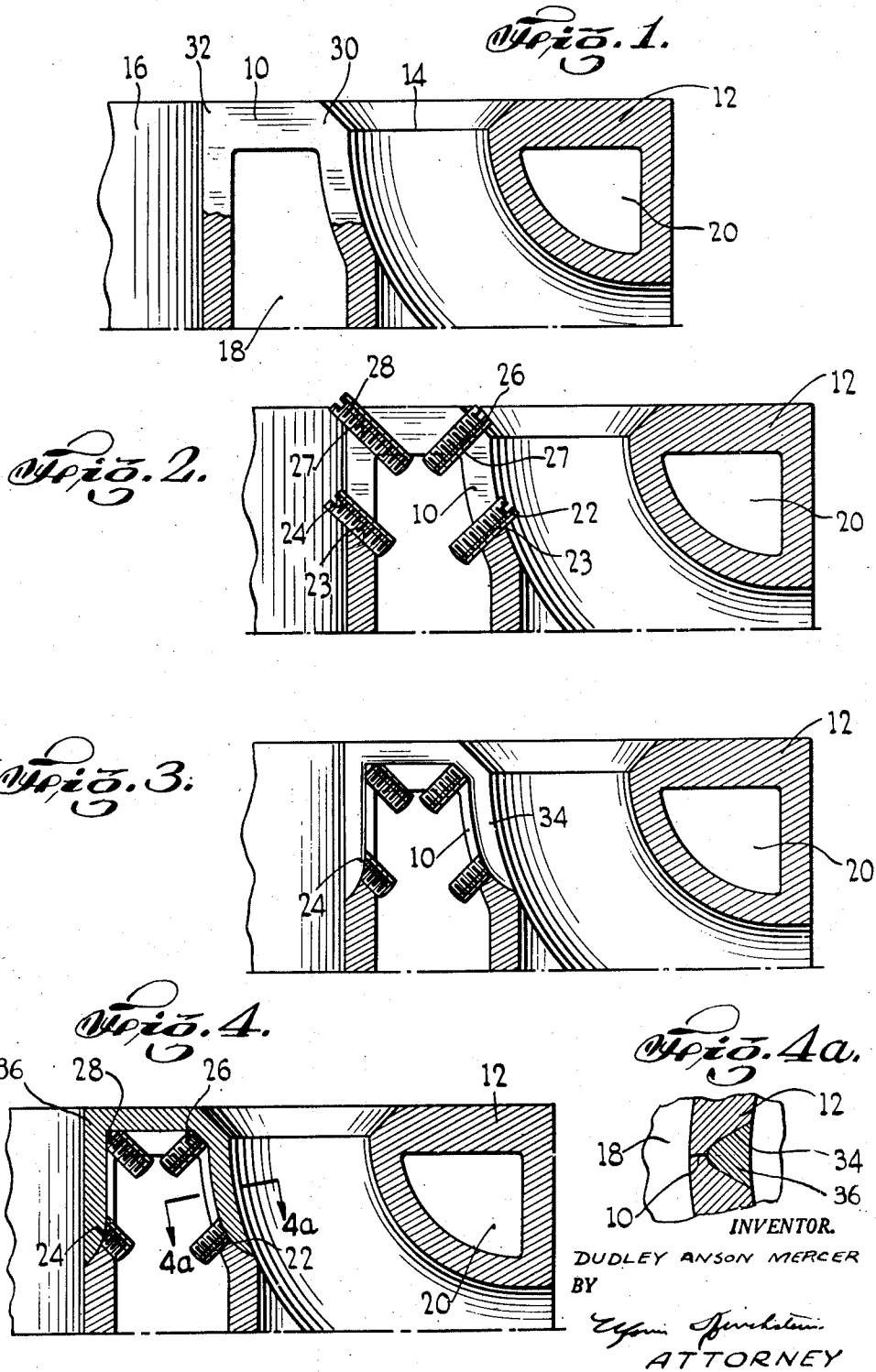
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2,482,925

METHOD FOR REPAIRING CRACKED HOLLOW METALLIC BODIES

Filed June 16, 1945

2 Sheets-Sheet 1



Sept. 27, 1949.

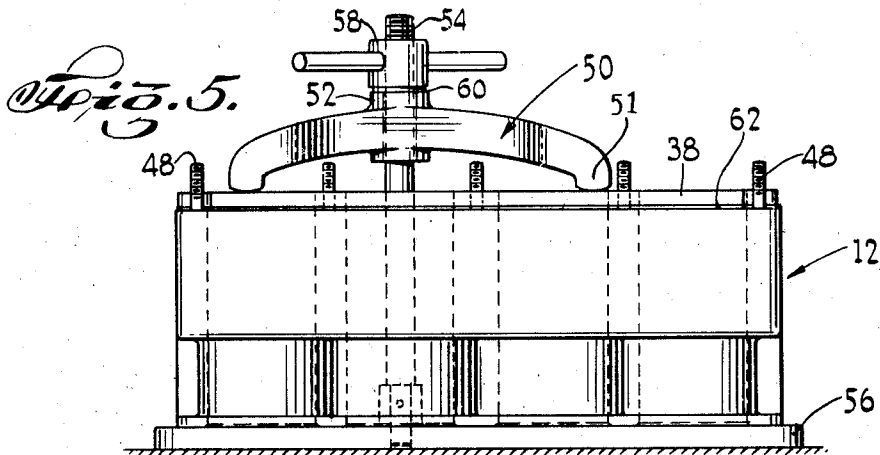
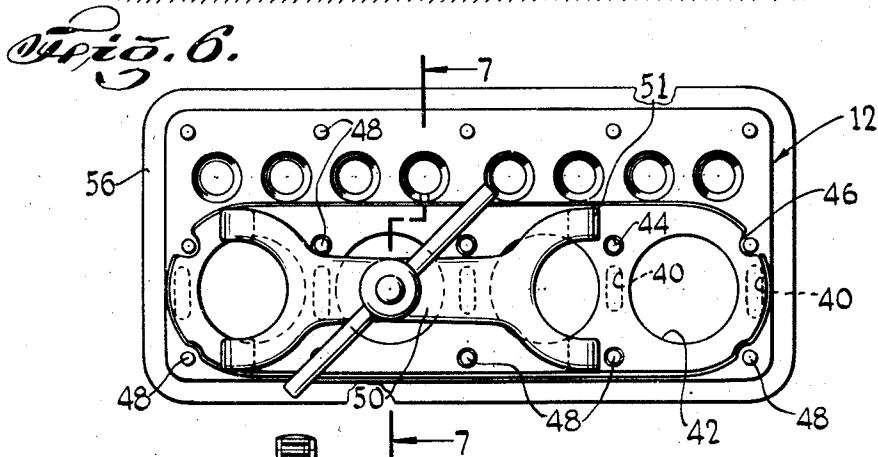
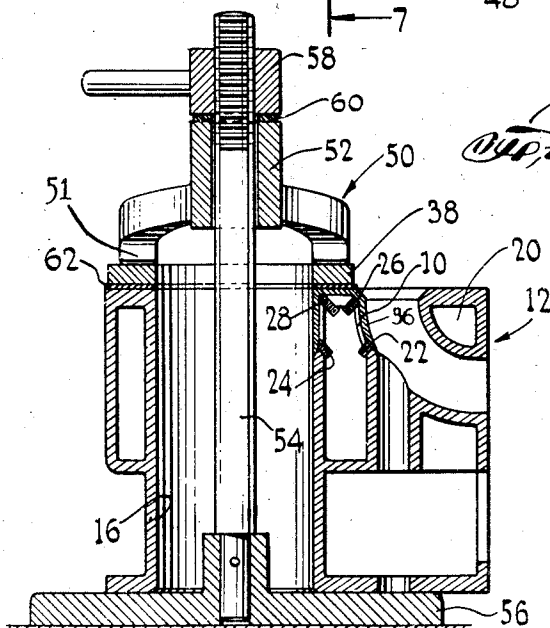
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METHOD FOR REPAIRING CRACKED HOLLOW METALLIC BODIES

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2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

2,482,925

METHOD FOR REPAIRING CRACKED
HOLLOW METALLIC BODIESDudley Anson Mercer, Bloomington, Ind., as-
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Application June 16, 1945, Serial No. 599,906

5 Claims. (Cl. 29—148)

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This invention relates to a method for repair-
ing cracked hollow metallic bodies.

It is the primary object of the invention to
provide a method of the character described for
effecting repairs quickly, economically and
simply, and in such manner that the same will
not reopen when subjected to severe stresses,
sudden or large temperature changes, or vi-
bration.

Other objects of the invention will in part be
obvious and in part hereinafter pointed out.

The invention accordingly consists in the fea-
tures of construction, combinations of elements,
and arrangement of parts which will be ex-
emplified in the construction hereinafter de-
scribed, and of which the scope of application will
be indicated in the appended claims.

In the accompanying drawing, in which is
shown one of the various possible embodiments
of this invention,

Fig. 1 is a sectional view through a crack in
an automobile engine block between a valve port
and a cylinder;

Figs. 2, 3 and 4 are similar views of said block
at successive stages in the repair of the crack;

Fig. 4a is a sectional view taken substantially
along the line 4a—4a of Fig. 4;

Fig. 5 is a side view of the block with a plate
mounted thereon to block off openings in the
water jacket preparatory to introducing into the
block a fluent pore-sealing material;

Fig. 6 is a top plan view of said block and
plate; and

Fig. 7 is an enlarged sectional view taken sub-
stantially along the line 7—7 of Fig. 6.

In general, the invention is carried out by
practicing the following steps: (1) locating the
crack, (2) isolating the crack from the sound
portion of cracked body, (3) inserting pins to
prevent relative movement of the walls of the
crack in the direction of the crack, (4) channel-
ing out the exposed side of the crack, (5) de-
positing sufficient metal in the resulting groove
by electric bonding to restore the original sur-
face, and (6) sealing the pores in the deposited
metal and the fine crevices around the pins.

Locating the crack

The position and course of the crack con-
veniently may be ascertained by cooling the
cracked body, thus causing the same to contract
and increasing the space between the walls of
the crack. Under some circumstances, the crack
may be so situated that the application of cold
tends to close the crack and in these cases the

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crack can be found by heating the body. The
body may be heated or chilled in any suitable
manner, and the way in which heating or cooling
is performed will, to a considerable extent, de-
pend upon the type of the body which is being
repaired. Thus, if the body is an engine block
such as is illustrated herein, or a cylinder head,
the same is most easily heated or cooled by in-
troducing a heating or cooling medium in the
water jacket. For example, to chill an engine
block, cool or even ice water can be circulated
through the water jacket. To heat the block,
hot water or steam can be introduced into said
jacket.

In Fig. 1 there is shown a crack 10 which has
been located in the block 12 of an automobile
engine. The course of said crack is from a valve
seat and port 14 to a cylinder 16. A part of the
crack runs across the top surface of the block.
Said block has the customary circulating pas-
sageways 18, 20 which form a water jacket sur-
rounding the cylinders and valves. As is usual,
the crack extends from the outside surface of the
block to the hollow interior thereof.

Isolating the crack

The next step in the practice of the invention
is to fix the position of the crack by separating
the intracrystalline or crystalline lines of cleav-
age, that present themselves at the time of frac-
ture, from the normal structure of the sound
metal. In this manner, the progression of the
crack in the body is prevented and the damaged
area is isolated from the remaining sound por-
tion of the body. Such isolation is accomplished,
according to the invention, by providing fixing
pins 22, 24, one at each end of the crack 10.
Preferably these pins are applied by first boring
terminal holes 23 in the crack at the ends there-
of. Said holes are so positioned that the ends
of the crack terminate in directions approxima-
tely normal to the walls of the holes, whereby the
ends of the crack appear to be diametrically dis-
posed with respect to the holes and the walls of
each hole are cracked at only one place. If de-
sired, the terminal holes may be smooth and
smooth fixing pins driven therein. In such case
the pins should be large enough so that they have
to be force-fitted. This is accomplished by hav-
ing the pins made slightly larger in diameter
than the holes and, since blocks are usually cast
and therefore relatively fragile, making the pins
of metal soft enough to be forced into the hole
without further cracking the block. A pin of
low carbon annealed steel is satisfactory for this

purpose. The pins also may be slightly tapered. Alternatively, the holes 23 may be tapped and the fixing pins 22, 24 have threads provided thereon so that said pins can be screwed tightly into the holes and firmly held in place. In this latter case, the pins or the holes may be slightly tapered to make sure that when the pins are tightened, they are rigidly secured in place.

Preventing relative movement of the walls of the crack in the direction of the crack

Either before or after the fixing pins 22, 24 are inserted, limit pins 26, 28 are applied. The function of these latter pins is to prevent relative movement in the direction of the crack between the portions of the metal body at the two sides of the crack. Said limit pins take up any stresses which may be induced into the body in the region of the repair. Accordingly, limit pins are placed wherever stress in tension, compression or shear, which might cause relative movement of the walls of the crack, could arise in the body after repair, regardless of the nature of the force giving rise to the stress. Such stresses usually are caused by thermal expansion or contraction, vibration or direct application of a strain. Such stresses also are created by applying a strain to a bend, and particularly to an abrupt bend. Places where stresses of this nature occur are well known to the automobile mechanic. For example, such stresses arise at and near the point of application of a load, resulting, for example, from an explosion in the cylinder or tightening the cylinder head on the engine block. Such stresses also might arise where the crack runs along an unsupported span for about one inch or more or extends around a corner connecting two walls, e. g., the top surface of the block and the cylinder wall. A point of high stress will be encountered where there is a sudden change in the temperature of the body. Good results are obtained where the pins are spaced an inch apart over the length of the crack.

The two main spots where a dislocating stress is most likely to occur in the crack 10 are the points 30, 32 at the valve seat and edge of the cylinder, respectively.

Therefore, according to my invention holes 27 are bored at said points and limit pins 26, 28 inserted in said holes. As in the case of the fixing pins 22, 24, the limit pins 26, 28 should be tightly fitted into the hole, either by screwing the same in or making a drive or force fit between the pins and the holes. It will be apparent that the fixing pins may, and preferably do, serve also as limit pins.

In the illustrative example, I have found that by locating all the pins 22—28 at an angle of about 45° to the top surface of the block, highly satisfactory results are obtained. However, the angles at which said pins are inserted may be varied at will as long as they still can assume any stress which would tend to relatively move the opposite walls of the repaired crack, and as long as the fixing pins 22, 24 are in holes 23 so located that the ends of a crack do not extend across any portion of the same.

The pins can, as shown, be of such length that they project into the circulating passageway 18 of the water jacket, thereby making certain that said pins have their temperature changed in advance of any change in temperature experienced by a surrounding part of the block due to change in temperature of the cooling medium. Projection of the pins into the circulating passageway

also reduces the possibility of overheating of pins and lessening the tightness of their fit in the holes 23, 27.

The diameter of the pins is relatively small, good results being secured when said diameter is about equal to the thickness of the cracked wall being repaired. Typical diameters range from one-eighth to one inch. Due to the manner in which both the fixing and limiting pins tie together the walls of the crack and cause them to act jointly as a single member, said pins are sometimes hereinafter referred to as an anchoring system.

The block 12 has the appearance shown in Fig. 2 subsequent to incorporation of the anchoring system.

It is pointed out that the fixing and limiting pins cause a spreading tension which also aids in preventing relative movement of the walls of the crack in a direction along the crack.

Channeling the exterior course of the crack

After the fixing and limit pins are applied, the external surface of the block is channeled along the course of the crack to provide a groove 34 (Fig. 3). Said groove is so fashioned that it follows the crack with the visible side of the crack running substantially along the center of the bottom wall of the groove (see Fig. 4a). The grooving operation may be carried out in any manner well known to the art, as for example by grinding or with a hammer and chisel. At the time the groove is formed, the projecting ends of the pins 22—28 are removed and the groove is cut through said pins. The size and cross-sectional contour of the groove are not critical. I have obtained satisfactory results with a V-shaped groove having a rounded bottom wall and side walls sloped at an angle of about 60°, the width and depth of the groove being about three-quarters of the thickness of the cracked wall of the block.

The foregoing sequence of steps may be modified, if desired, to carry out the channeling operation before the fixing or limiting pins are inserted. In such case, it is preferable to dispose the head of the pin below the exposed surface of the block, e. g., the cylinder wall, valve seat or top of the block. It is further desirable, where such sequence of steps is employed, to locate the head of the pin near the bottom of the groove or to countersink said pin in the groove, for reasons which will shortly be apparent.

Depositing metal in the groove

After the anchoring system has been applied and the crack channeled, metal 36 is deposited in the groove by electric bonding, it being remembered that the surface of the groove includes the heads of the fixing and limit pins as well as a part of the engine block, so that the electrically bonded metal will unitarily joint the anchoring system and the block.

The term "electric bonding" as used herein denotes an operation wherein metal is fused to and deposited upon a metallic surface from a consumable metallic electrode which is touched to point after point of said surface, while a low voltage, high amperage current flows through the electrode and surface. By way of example, 6 volts and 200 amperes are satisfactory current conditions with a 1/8" nickel electrode, but it will be understood that both the voltage and amperage may be varied considerably from, say,

$\frac{1}{2}$ to 20 volts and 200 to 400 amperes. The metal of the electrode and of the metallic surface are fused together at their point of contact at the moment the electrode touches said surface whereby to firmly bond the deposited metal to the surface. The current and voltage do not range so high as to deeply affect the metallic surface, as where an arc welding voltage and current are used. It may be mentioned that depositing metal in the groove by arc welding will not yield satisfactory results as in such case, with the large current and amperage employed the block will be heated deeply and create new stresses upon cooling which may give rise to further cracking. However, when metal is deposited in the channel by electric bonding the heating of the block is only skin deep and no new local stresses are set up.

Any suitable metal may be deposited in the groove as, for example, nickel, iron, copper, brass and bronze. The use of nickel is preferred because the same has no tendency to oxidize or corrode under the conditions to which objects such as engine cylinder blocks are normally subjected.

The electric bonding step may also include any additional processing which serves to compact the electrically bonded deposited metal, as for example, rapidly vibrating the metallic electrode toward and away from the metallic surface and/or directing a stream of a gas non-combustible with air against the metal being deposited.

Sufficient electrically bonded metal is deposited in the groove to build beyond the original surface of the block, i. e., before channeling and/or wear, and after this amount of metal is deposited the block may be subjected to a metal-removing operation to bring the level of the electrically bonded deposited metal back to such original surface. Suitable metal-removing operations include grinding, planing, shaping, milling, boring, chiseling and filing.

The repair now has the final finished appearance indicated in Fig. 4 and is characterized by the provision of an anchoring system which isolates the crack and prevents relative movement of the side walls thereof and a bonding system which couples into an integral body the metal of the anchoring system and the surrounding body of the object being repaired.

Sealing the repair

Either before or after the metal-removing operation, but after the anchoring system has been installed and the electrically bonded metal applied, the final step of the invention is carried out. This comprises sealing the pores or interstices in the deposited metal and the fine crevices around the pins.

Although it is essential in carrying out my invention that the metal within the groove be applied by electric bonding in order to prevent overheating the body while yet securing a good bond between the deposited metal, the pins and said body, nevertheless metal deposited by electric bonding is inherently spongy and there is, therefore, a tendency for fluid to leak there-through as well as through the hair line crack around the pins. Such leakage increases as the repair ages. It is for this reason that the final step of my invention is essential.

This step is performed by subjecting the block in the region of the repaired crack to the action of a sealing solution which is caused to permeate

at least partially into the electrically bonded metal and which includes a sealing material characterized by its ability to solidify from the solution, i. e., leave a solid deposit within said metal either in normal course or upon special treatment whereby to effect a water and air-proof seal. For example, said sealing material may be characterized by its ability to solidify from the sealing solution upon the application of heat, or of cold, or of pressure to the solution, or when the solution is subjected to pressure in the presence of either heat or cold. Alternatively, the sealing material may be characterized by its ability to solidify from the solution merely upon exposure to air as, for example, upon dehydration. The solution must be readily removable from the block where the material has not solidified and solidification of the material must be slow or controllable so that deposit of a large mass of a solid can be prevented. Materials having the foregoing characteristics, and which, therefore, are capable of use in conjunction with my invention to fill in the pores in the electrically bonded metal and the fine crevices around the pins, are the various alkali metal silicates, drying oils and ground flaxseed. The fluent vehicle preferably is water in which the sealing material is dissolved or dispersed.

In addition, the sealing solution may include dispersed powders of metals having atomic weights not less than that of aluminum. I have found that these powders cause the sealing material to bond more firmly with the metal of the article and of the repair. Examples of such substances are aluminum, iron and copper, which have been comminuted by ball milling to amorphous powders.

I have also obtained good results where the powdered iron is derived by reducing rouge (iron oxide), with hydrogen in a manner well known by chemists. The resultant amorphous iron powder is extremely fine and pure.

The sealing solution also may include a substance which will react mildly with the metal of the article being repaired or that of the pins or electrically bonded metal. This is believed to aid the seal by cleaning the surfaces of the material in the crack or cleaning the pins or electrically bonded metal and thereby enabling the sealing material to cohere better in the repair. Such materials include, by way of example, sodium, magnesium and iron hydroxides.

If desired, the sealing solution may also comprise a filler, as for instance, fuller's earth or alumina.

Another substance whose incorporation in the sealing solution increases the efficacy of the seal is any lithium compound which does not react with water, such compound including, by way of example, lithium silicate, hydroxide, chloride and nitrate.

Without limiting my invention thereto, I have given below examples of various sealing solutions which will perform satisfactorily in the practice of my invention, and of which each includes a plurality of the above mentioned substances:

Example 1

70	Sodium silicate, 47° Baumé	gals.	55
	Fuller's earth	lbs.	10
	Copper powder	lbs.	1
	Aluminum powder	lbs.	1
	Flaxseed meal	lbs.	1
75	Water	gals.	5

These ingredients are thoroughly and intimately blended by placing the same in a fast mixer where they are worked for approximately two hours and then drawn off. The resulting mixture is a concentrated sealing solution which is used by adding one pint thereof to six gallons of water. Weaker or stronger diluted solutions can also be employed. The diluted sealing solution is particularly well suited for use in the repair of cracks in engine blocks in accordance with my invention. If said solution is circulated past the electrically bonded metal at a rate of about 10 cubic feet per minute and at a temperature of about 160° F. for about 20 minutes, it will completely seal the pores in the electrically bonded metal and the fine crevices around the pins.

It should be particularly noted that these pores and crevices are of a considerable lesser order of magnitude than the crack being repaired, and it is for this reason, I believe, that the sealing solution, which at best could only serve as a temporary expedient to close the crack, will permanently seal the pores and crevices.

Example 2

Sodium silicate, 47° Baumé	cc.	100
Potassium silicate, 40.5° Baumé	cc.	25
Amorphous iron (prepared by reducing iron oxide with hydrogen)	grams.	3
Powdered anhydrous alumina	do.	5
Water	cc.	35

The concentrated sealing solution is prepared by mixing the alumina and amorphous iron with water and adding the mixture to the silicates which previously have been compounded. Said solution is diluted in a ratio from one pint thereof to about two to five gallons of water. The dilute sealing solution, which sets by dehydration, is satisfactory for general operations. Due to the presence of the pure iron powder, the seal will bond particularly rapidly with the metal of the cracked article and will also bond well with the pins and the electrically bonded metal.

Example 3

Sodium silicate, 47° Baumé	cc.	100
Potassium silicate, 40.5° Baumé	cc.	5
Red iron oxide	grams.	3
Soy bean oil	cc.	4
Sodium hydroxide	grams.	4
Water	cc.	25

The concentrated sealing solution is prepared by mixing the sodium hydroxide in half of the water, and then adding thereto the soy bean oil and stirring the resulting mixture. The rest of the water is added to this mixture and the same is then added to the silicates which previously have been compounded and the entire fluid body mixed well. The concentrated sealing solution is diluted in the ratio of about from one part thereof to about 200 to 5,000 parts of water. At the former ratio, particularly good results are obtained with sulphated castings. This sealing solution, in general, is useful in the repair of cracked castings which are subjected to acids.

Example 4

Sodium silicate, 47° Baumé	cc.	100
Potassium silicate, 40.5° Baumé	cc.	5
Lithium silicate, 40° Baumé	cc.	1
Magnesium hydroxide	grams.	0.2
Anhydrous alumina powder	do.	0.4
Oleic acid	do.	0.2
Ferric hydroxide	do.	0.1
Water	cc.	20

The concentrated sealing solution is prepared by adding water to a mixture of the alumina and the magnesium hydroxide in sufficient quantities to make a thin paste. The oleic acid is added to said paste and the mass is heated to emulsify the same. Then, enough water is added to make a thin liquor. The ferric hydroxide is added to the silicates which previously have been compounded and the mixture is stirred well while adding to it the thin liquor. The concentrated sealing solution may be used in dilutions of about one part thereof to from about 1,000 to 50 parts of water. In dilute form, said solution shows good results in the repair of cracks for articles employed for heavy duty operation in salt water, and, in general for the repair of cracks in heavy thick castings composed either of ferrous or non-ferrous alloys. Castings repaired in accordance with my invention and with the use of this sealing solution, will stand a great deal of vibration, as the seal is believed to be a heavy alkaline saponified gel, with good surface tension.

Although the alkali metal silicates described in the various foregoing examples have all been illustrated as having the same viscosity, it will be understood that these specific viscosities are only exemplative.

Although I contemplate passing the solidifiable fluent material over either side of the electrically bonded metal, that is, either over the surface of the hollow body which has been grooved and electrically bonded, or within the interior of said body, it is much simpler when repairing certain types of metallic castings to introduce the fluent pore-sealing material inside the body. This is particularly so where the repair is to be effected in a body such as an engine block which has internal passageways adapted normally to pass a circulating medium. The only drawback to the use of these passageways is that many of them open on the top face of the block and this would entail the laborious task of refastening the cylinder head on the block after repairing the crack and, possibly, subsequently removing said head to ascertain whether the crack is completely repaired.

To aid in carrying out my invention I have provided an apparatus through whose use the circulating system of the block may be employed to receive said solidifiable fluent material without the tedious procedure of mounting and subsequently dismounting the cylinder head. Said apparatus comprises a plate 38 of such configuration that when superimposed on the engine block 12, it will close off all water passageways opening at the top surface of said block. A satisfactory configuration is seen in Fig. 6 wherein the openings 40 which normally furnish communication for a coolant between the cylinder block and the valve head are shown blocked off by the plate 38. If desired, the plate 38 may be lightened by providing apertures 42 therein, matching the cylinder bores 16, and the plate 38 may be skeletonized generally as long as it effectively blocks the openings 40. Said plate may also be provided with apertures 44 and indentations 46 to afford free passage for the cylinder head bolts 48.

In order to avoid the troublesome individual attachment of nuts on the several bolts 48, I provide a single means to detachably secure the plate 38 to a block. Said means comprises a spider 50 having a plurality of depending coplanar feet 51 which are adapted to rest on the upper surface of the plate 38. These feet radi-

ate from a central hub 52 which is apertured to slidably receive a rod 54. Said rod, which is adapted to extend through a cylinder bore 16, carries a plate 56 at its lower end which engages the bottom of the block. The upper end of said rod is threaded to receive a capstan nut 58. A washer 60 is interposed between the nut 58 and hub 52.

The foregoing apparatus is employed in the following manner: After the crack 10 (Fig. 7) has been located, pinned, grooved, electrically bonded and had the exposed surfaces of the electrically bonded material machined, the block 12 is placed upon the plate 56 and a gasket 62 of the type conventionally employed with the block 12 (but abbreviated to the approximate contour of the plate 56) is placed upon the upper surface of said block. Next, the blocking plate 38 is set on the gasket and the spider 50 slipped on the rod 54. Then the nut 58 is threaded on said rod and is screwed fast. The block is now ready to have the pore-sealing fluent material introduced through the bottom radiator connection. If desired, said material may be circulated through the block by employing another connection to the block as, for example, the drain tap or one of the openings 40 which may be left unblocked by the plate 38. Circulation is facilitated by using a flow unit including a pump and heater. Several plates may be provided, one for each different type of engine, or a single plate may be employed which is large enough for any block and which has a single aperture to receive only the rod 54.

The above apparatus for closing the circulating openings in the top of an engine block also may serve as a means for testing the repaired block for leakage, the same being accomplished merely by leaving the apparatus in place after said fluent material has been circulated through the block and after sufficient time has elapsed to solidify said material in the deposited metal. A fluent testing substance, such as a smoky gas or water, is placed under pressure in said block, and if the crack is not repaired, the testing material will leak therethrough.

It will further be appreciated that the solidifiable fluent material may be circulated through the block under pressure and the repair watched during the period of circulation. When leaking stops, the repair will be completely effectuated. Thus, during this period, said apparatus functions both as a repairing means and as a testing means.

It may be mentioned that the method of repair described herein and the apparatus used in conjunction therewith is mostly used in connection with the repair of cracks in hollow cast bodies, inasmuch as, although welding, due to its simplicity and economy, is ordinarily employed to repair cracks, cast bodies cannot be welded without an elaborate pre-treatment which renders the repair by welding of such bodies costly in comparison with the method of repairing said bodies in accordance with the present invention.

It will thus be seen that I have provided a method for repairing cracked hollow metallic bodies which achieves the several objects of my invention and which is well adapted to meet the conditions of practical use.

As various possible embodiments might be made of the above invention and as various changes might be made in the embodiment above set forth, it is to be understood that all matter here-

in set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

Having thus described my invention, I claim as new and desire to secure by Letters Patent:

1. A method of repairing a hollow cast body having a crack therein extending from the hollow interior to the exterior thereof: said method comprising locating the crack, forming holes in the body from the exterior to the interior thereof through the ends of the crack, forming holes in the body from the exterior to the interior thereof at spaced points along the crack, tightly fitting pins in said holes whereby to isolate the crack from the sound portion of the cracked body and prevent relative movement of the walls of the crack along the crack, channeling the exterior of said body along the course of the crack, and then depositing sufficient metal in the resulting groove and on the pins by electric bonding to restore the original surface of the body.

2. A method of repairing a hollow cast body having a crack therein extending from the hollow interior to the exterior thereof: said method comprising locating the crack, forming holes in the body from the exterior to the interior thereof through the ends of the crack, forming holes in the body from the exterior to the interior thereof at spaced points along the crack, where stressing of the body after repair of the crack would cause relative movement of the walls of the crack in a direction along the crack, tightly fitting pins in said holes whereby to isolate the crack from the sound portion of the cracked body and prevent relative movement of the walls of the crack along the crack, channeling the exterior of said body along the course of the crack, and then depositing sufficient metal in the resulting groove and on the pins by electric bonding to restore the original surface of the body.

3. A method of repairing a hollow cast body having a crack therein extending from the hollow interior to the exterior thereof: said method comprising locating the crack, forming holes in the body from the exterior to the interior thereof through the ends of the crack, forming holes in the body from the exterior to the interior thereof at spaced points along the crack, tightly fitting pins in said holes whereby to isolate the crack from the sound portion of the cracked body and prevent relative movement of the walls of the crack along the crack, channeling the exterior of said body along the course of the crack, then depositing sufficient metal in the resulting groove and on the pins by electric bonding to restore the original surface of the body, the crevices around the pins and the pores in the deposited metal being of a lesser order of magnitude than the crack, and sealing the pores in the deposited metal and the fine crevices around the pins, by introducing into the interior of said body in the region of the crack a fluent material which will permeate at least partially into said crevices and pores and solidify therein.

4. A method of repairing a hollow cast body having a crack therein extending from the hollow interior to the exterior thereof: said method comprising locating the crack, forming holes in the body from the exterior to the interior thereof through the ends of the crack, forming holes in the body from the exterior to the interior thereof at spaced points along the crack, tapping said holes, tightly screwing threaded pins in said holes whereby to isolate the crack from the sound portion of the cracked body and prevent relative

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movement of the walls of the crack along the crack, channeling the exterior of said body along the course of the crack, then depositing sufficient metal in the resulting groove and on the pins by electric bonding to restore the original surface of the body, the crevices around the pins and the pores in the deposited metal being of a lesser order of magnitude than the crack, and sealing the pores in the deposited metal and the fine crevices around the pins, by introducing into the interior of said body in the region of the crack a fluent material which will permeate at least partially into said crevices and pores and solidify therein.

5. A method as set forth in claim 4 wherein the upper ends of the pins are placed below the original surface of the body before metal is deposited by electric bonding.

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