Aug. 3, 1954 L. V. JONES ET AL 2,685,565

FILTERING AND CLEANING MEANS

Filed Nov. 5, 1949

2 Sheets-Sheet 1

Fig. 1

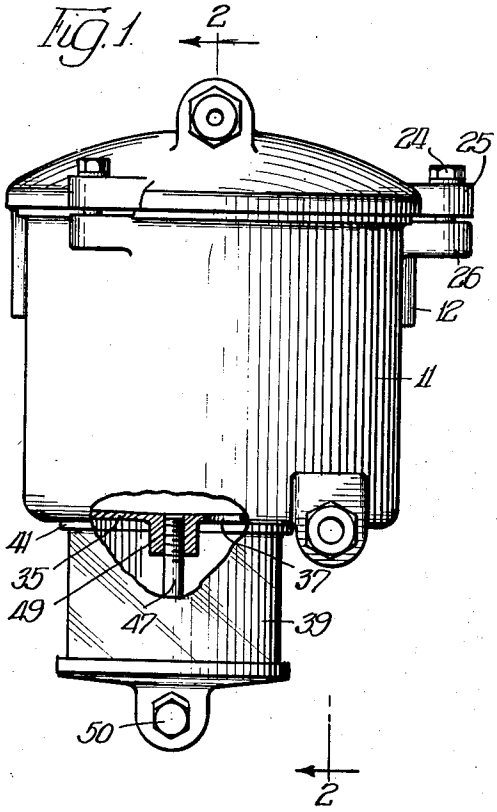


Fig. 2

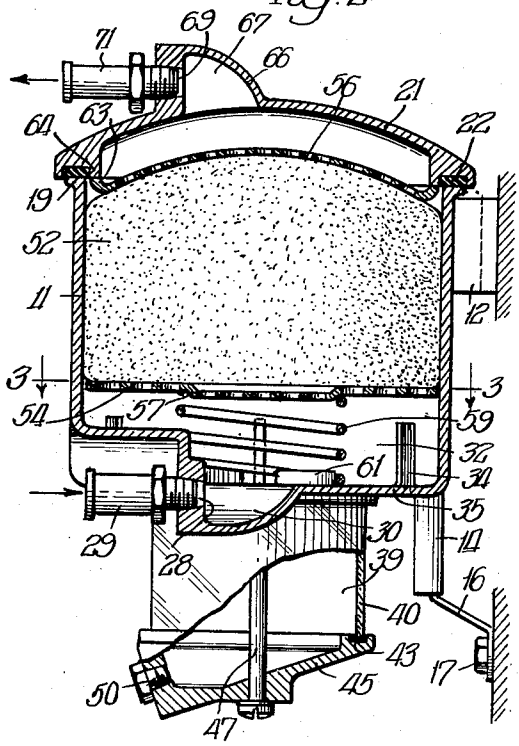
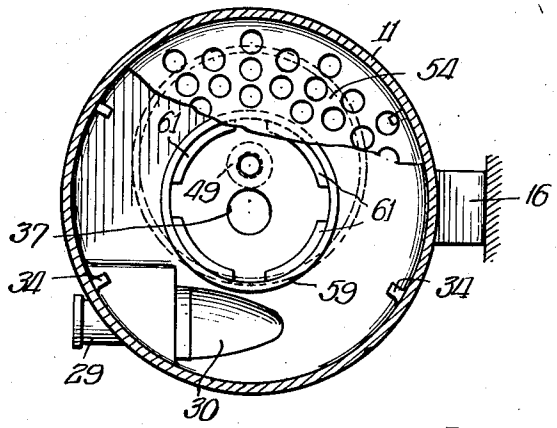


Fig. 3



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2 Sheets-Sheet 2

Fig. 4

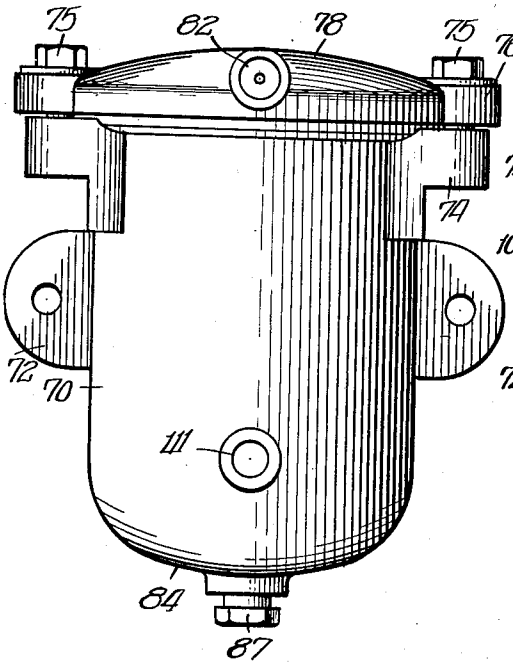


Fig. 5

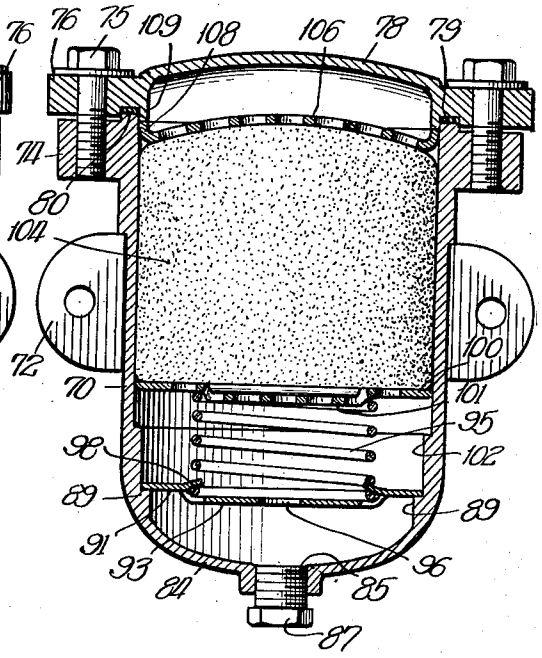
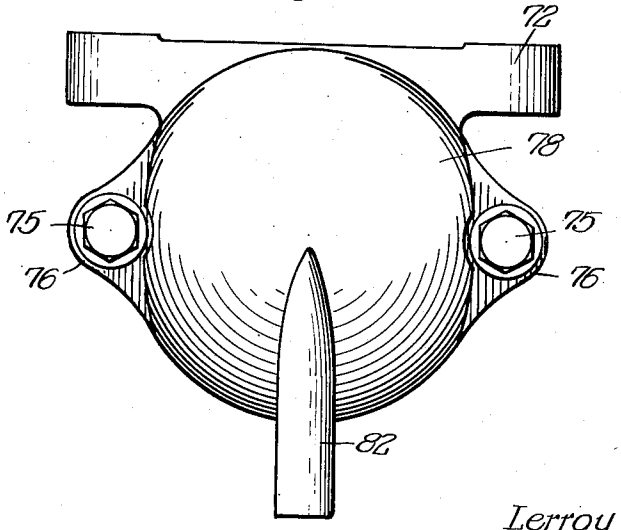


Fig. 6



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2,685,565

FILTERING AND CLEANING MEANS

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8 Claims. (Cl. 204—197)

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This invention relates to a new and improved filtering and cleaning means and more particularly to filter constructions and filtering agents in combination especially adapted for use in connection with the cooling systems of internal combustion engines.

Filter constructions have heretofore been developed for the purpose of mechanically filtering the liquid coolant used in connection with internal combustion engines. While such filters are capable of beneficial results, they do not solve the real problem since they are incapable of doing more than merely removing such material as may be entrained in the coolant liquid. Such filtering has no effect upon scale deposits or layers of sedimentation formed upon the engine and heat exchange surfaces in contact with the coolant.

For the proper functioning of an internal combustion engine, it is essential that cooling be efficient and uniform with regard to the cooling areas provided by the engine design and construction. Any deposits upon surfaces contacted by coolant fluid hinders heat transfer and consequent cooling. If the deposits are non-uniform as to location or thickness or their effect upon heat transfer, there will be localized variations in temperature in the engine. Such variations may set up stresses in the engine block which have deleterious effects in twisting or deforming contact and bearing surfaces. Also, inadequate local cooling may cause burn-out of valves or valve seats.

Chemical analyses of deposits found on engine coolant contact surfaces have shown these deposits to be a mixture of inert sedimentation, various iron oxides in layer formations and insoluble calcium and magnesium compounds. Many of these formations are caused to accumulate against the natural flow of the coolant by the presence of water scale acting as a cement. Other specimens of deposits show simple accumulations of iron oxides and, in substantially all cases, there exists an inner, thin layer of tightly bonded iron oxide formed in intimate contact with the cast iron surface. Radiator accumulations are similar, with the exceptions that no locally formed iron oxide is present to aid in the binding process and that sedimentation plays a more important role. In the radiator, while adequate heat transfer is essential, local heat transfer differentials are of minor importance.

It is an object of the present invention to provide a new and improved filtering and cleaning means especially adapted for use in filtering the coolant liquid and cleaning the interior surfaces in the cooling system of an internal combustion engine.

It is a further object to provide means adapted to carry out a simple and economical chemical,

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electro-chemical, and mechanical method for treating an internal combustion engine system whereby the surfaces of the system in contact with the coolant, both engine and heat exchange portions, are effectively and safely cleaned and maintained in clean condition so that their heat transfer and heat dissipation functions can be uniformly effective.

It is also an object to provide means for dissolving or breaking down and loosening water scale deposits or iron oxide deposits or other deposits or sedimentation and removing all such suspended foreign matter from the coolant liquid by mechanical filtration.

Other and further objects will appear as the description proceeds.

We have shown certain preferred embodiments of our invention in the accompanying drawings, in which—

Figure 1 is an elevation, partly broken away, showing one form of construction;

Figure 2 is a vertical section taken on line 2—2 of Figure 1;

Figure 3 is a horizontal section, partly broken away, taken on line 3—3 of Figure 2;

Figure 4 is a vertical elevation showing a modified form of construction;

Figure 5 is a transverse vertical section through the construction of Figure 4; and

Figure 6 is a plan view of the construction shown in Figure 4.

Referring first to the form of construction shown in Figures 1 to 3 inclusive, the filter housing member 11 is provided with integral securing legs 12 which may be connected to any supporting surface. This member 11 is also provided with a depending lug 14 to which is connected a resilient arm 16 which may be connected to the supporting surface as by the bolt, indicated at 17, of Figure 2. The top of housing member 11 is open and has a flanged edge 19 upon which is fitted a cover member 21. This cover member carries a recessed gasket 22 which engages the flange 19. The cover is held in place by bolts 24 which extend through lugs 25 on the cover and lugs 26 formed on the body member 11, as shown in Figure 1.

The lower portion of the body member 11 is provided with an inlet opening 28, into which is fitted a threaded connecting plug 29. The opening 28 leads into a recessed passage 30 which connects to the lower chamber 32 in the filter. Around the edges of this chamber 32 are located a plurality of vertically extending lugs 34 which are formed integrally with the walls of the body member 11. As best shown in Figure 1, the floor or bottom 35 of the chamber 32 is provided with a drain opening 37 which discharges into the sump 39. The sump is shown as formed of a tubular glass member 40, the upper edge of which

fits into a flange 41 on the bottom of the member 11. The lower end of this member 40 fits against a packing 43 carried in a groove in the sump bottom member 45. This member 45 is held in place by a bolt 47 which, as shown in Figure 1, is threaded into a boss 49 extending downwardly from the bottom 35 of the body member 11. This sump bottom 45 is formed with a concave upper surface leading towards a discharge orifice closed by the plug 50.

The replaceable filter cartridge 52 is carried in the housing 11 between the lower plate 54 and the upper plate 56. Both of these plates are perforated, as shown, to permit passage of fluid therethrough. The lower plate 54 has a central circular depressed boss 57, about which fits the upper end of the supporting coil spring 58. The lower end of this spring 59 fits about an interrupted flange 61 formed on the upper face of the bottom wall 35 of the housing 11. The upper plate 56, as best shown in Figure 2, has its central portion convex upwardly and is provided with a peripheral upturned flange 63 which fits against a flange 64 on the cover, this flange 64 being located internally of the gasket 22. The cover 21 is provided with an upwardly extending raised portion 66 forming a passage 67 leading to a threaded orifice 69, into which is screwed a connecting fitting 71.

The form of construction shown in Figures 4 to 6 inclusive is generally similar to that shown in Figures 1 to 3. The filter housing member 70 is provided with the spaced lugs 71, by means of which it may be secured to any supporting surface. The housing 70 is provided with upper lugs 74 to receive securing bolts 75 which pass through lugs 76 extending from the cover member 78. This cover member 78 carries the recessed gasket 79 which engages the upwardly extending flange 80 located around the upper periphery of the body member 70. As shown in Figures 4 and 6, cover member 78 is provided with a radially extending outlet passage 82.

The bottom of the housing member 70 is rounded, as shown at 84, and provided with a central threaded opening 85 closed by the plug 87. The lateral walls of the chamber formed by the housing 70 are provided with spaced lugs 89, upon which rest the spring support plate 91. This plate 91 has a central depressed portion 93 adapted to receive the lower end of the supporting spring 95. The center of the depressed portion 93 is shown as provided with an opening 96. Adjacent the lateral edges of this depressed portion 93 are located the tongues 98 which serve to hold the spring 95 in place. The cartridge supporting plate 100 has a central depressed portion 101 which fits into the upper end of the spring 95. This plate 100, as shown, is perforated throughout the central portion of its area. The inner walls of the chambers 70 are provided with lugs 102 which serve to limit downward movement of the plate 100. The replaceable filter cartridge 104 fits on plate 100, and the top pressure plate 106 rests upon the upper surface of the filter cartridge. This plate 106 is perforated and convex upwardly, as shown, with the upturned circumferential flange 108 engaging the internal flange 109 and the cover 78. The inlet passage 111, shown on Figure 4, is located at a level between the plate 91 and the plate 100.

In the use of either form of filter, the filter is connected to the cooling system of the internal combustion engine in such manner that at least a portion of the coolant liquid passes continuously through the filter. This fluid enters the inlet or intake which, in each case, is located at the lower portion of the filter, passes upwardly through the replaceable cartridge and out of the top of the filter through the outlet passage. Any entrained solids which are caught on the lower face of the filter tend to deposit in the chamber below the filter cartridge. In the form of construction shown in Figure 1, such material gravitates towards the central opening 37 where it deposits into the sump 39. Here, it will be visible through the glass walls of the sump and may be removed from time to time by temporarily unscrewing the plug 50. In the form of construction shown in Figures 4 to 6, such solid material tends to pass down through the opening 96 in the spring support plate 93 and become deposited in the chamber below that plate. Here, again, it may be removed by unscrewing the plug 87.

The form of construction shown in Figures 1 to 3 is especially designed for use with trucks or vehicles having large motors and, consequently, large quantities of coolant to be filtered. The more simple form of construction shown in Figures 4 to 6 is especially designed and adapted for use in connection with light trucks or passenger vehicles.

The replaceable cartridge 52 of the first construction and the similar cartridge 104 of the second construction may be identical, except for size and shape. These cartridges are enclosed in an outer fabric covering, this covering being of such a nature and texture as to permit passage of the coolant through the cartridge for filtering purposes and, yet, being of sufficiently fine mesh to retain the filtering material in the fabric covering.

The particular constituents of the filter cartridges have been developed for the purpose of effectively cleaning the coolant liquid and, through the coolant liquid, effectively cleaning the surfaces in the engine and in the heat transfer apparatus, such as the radiator. The constituents are also designed to maintain the various surfaces clean during continued use. Since there are a number of elements to be attacked and removed in carrying out this function, the filter cartridge contains a plurality of chemical reagents. Water scale deposits are removed by the action of sodium tetraphosphate introduced into the system by the coolant passing through the cartridge. These water scale deposits of calcium and magnesium dissolve, ionize and are complexed by the sequestering action of the anions formed. Sodium tetraphosphate is especially well adapted for this role, since its use eliminates the necessity for maintaining the highly alkaline solutions which are required by other common scale-removing reagents.

To directly attack the heavy iron oxide formations, a method of electrolytic reduction is employed. The electrolytic cell is set up by the introduction into the system of an expendable anodic metal high in the electro-chemical series with respect to iron. This may be done in the construction shown by making the upper or lower plates 54 and 56 of Figure 2 and 100 and 106 of Figure 5, or both, of such a metal. A metal especially suitable for this purpose because of the fact that it does not become passivated early in the process is magnesium. Other suitable metals are aluminum and zinc. The anodic magnesium, then, located in the filter maintains the cast iron coolant contact surfaces

of the engine block electronegative. An electrolyte circuit is formed by the inlet and outlet hose connections to the filter which carry the coolant from the engine to the filter and back. The electrical circuit is completed through the metal attachment surface of the filter, usually the firewall in an automobile, and the engine-to-frame electric bond, which is necessary to the operation of the ignition system of the motor vehicle. The magnesium ions from the anode are immediately complexed by the sequestering additive, sodium tetraphosphate, which serves to prevent such ions having a detrimental effect on the iron surfaces of the engine and the brass surfaces of the heat exchanger or radiator.

The filter operation, in part, can be described as a process of employing current generated from a galvanic couple between the iron surface of the engine and a metal high in the electro-chemical series to chemically reduce valence 3 iron oxide surfaces to valence 2 iron oxide surfaces. Chemical means are introduced into the coolant which will react with valence 2 iron oxides to form a compound at the iron surface which is insoluble in the coolant. This compound constitutes an inhibiting film and the preferred film forming reagents are sodium chromate and sodium nitrite.

The current generated by a galvanic couple of this nature would not produce the desired result were it not for the fact that as small portions of the iron oxide surfaces are reduced, the formation of the insoluble film removes that portion of the surface from the cell. As long as iron oxides of any valence are exposed to an electron excess, continued reduction will occur. If, however, at an intermediate stage of reduction, in the present case at the valence 2 level, a chemical reaction occurs between valence 2 iron and a reagent introduced into the system, electron excesses can no longer escape; thus, they act only at those surfaces which are still able to provide an escape path. It is this process of gradual removal of portions of the surface from participation in the cell action that enables the film formation to gradually cover the entire surface.

Upon the cathodic iron of the engine block, iron oxide or rust layers are built up containing FeO, Fe_3O_4 and Fe_2O_3 where the electron excess seeks to escape. The interface reduction of valence 3 iron to valence 2 iron provides such an escape as to allow the cell action to continue. As the ferric oxide is transformed to ferrous oxide, the water scale-removing agent, sodium tetraphosphate, is simultaneously at work. The combined action results in a gradual disintegration of the deposit so that the film forming chemicals can come into contact with the valence 2 iron oxide. The sodium tetraphosphate also acts to prevent migration of the ions from the magnesium anode to the iron surfaces and then deposition thereon as compounds. The heat exchange surfaces are not affected by the cell action, as there is no migration path for the electrons beyond the metal surfaces.

The sodium chromate and sodium nitrite are of great importance in the chemical reactions which take place. The FeO must be prevented from being reduced down to metallic iron, since the iron will only reverse the reaction to reform FeO which, when reformed, will not be tightly bonded as previously. Sodium chromate reacts with the ferrous oxide to form ferrous chromate according to the following equation:

$$FeO \cdot H_2O + CrO_4^{=} \rightarrow FeCrO_4 + 2OH^-$$

In turn, the sodium nitrite reacts with the dissolved oxygen in the coolant to speed the formation of a water-insoluble chromate film and to prevent the formation of soluble dichromates. Because of the thinness of the rust layer on some portions of the cast iron, the chromate and nitrite anions at such portions will be diffused at a faster rate than at other localities. Thus, those surfaces on which deposits are of the least thickness will become passivated and removed from active participation in the magnesium-iron electrolytic cell first. The cell action on the unpassivated surfaces continues until all of the engine coolant contact surfaces become cleaned and passivated, at which time the anodic magnesium becomes relatively inactive. Thus, the anodic reaction of magnesium ionization decreases as the cathodic stimulation, or the process of reducing iron in the iron oxide, decreases. As disintegration of these surface deposits occurs, the released formations are carried off by the flowing coolant to the filter and removed by the mechanical filtering action of the filter cartridge.

A further constituent of the filter cartridge is preferably a water softening medium, such as a natural zeolite, greensand. The use of the zeolite in the filter allows later additions of coolant water to the system to be made without the risk of further scale deposition. The zeolite in the cartridge serves to provide a safeguard for the sodium tetraphosphate and the two are always in equilibrium with regard to the amount of calcium and magnesium ions they are keeping out of the coolant. Should a coolant loss be experienced, the total amount of sodium tetraphosphate would be reduced and thus its unused capacity to remove the ions would also be reduced but, since the equilibrium between the zeolite and the sodium tetraphosphate has been disturbed, passage of the coolant through the zeolite will cause partial regeneration of the sodium tetraphosphate until equilibrium is reestablished. Further corrosion is prevented by the presence of the continuous iron chromate film, and further sedimentation accumulations are prevented by the continuous filtration of the coolant.

While the specific proportion of each reagent to be placed in the replaceable cartridge may be varied to a substantial extent, depending upon conditions to be met and requirements of the particular type of coolant liquid used, the following proportions have been found generally effective:

10 parts sodium tetraphosphate
6 parts sodium nitrite
6 parts sodium chromate
80 parts natural zeolite greensand
80 parts silica filtering sand

Both the silica filtering sand and the zeolite have a part in the mechanical filtering effect of the filtering cartridge.

The total weight of the cartridge for the filter adapted for truck use, as shown in Figures 1 to 3, would be on the order of two and one-half pounds, while the cartridge for the smaller filter, shown in Figures 4 to 6, would be on the order of one and one-quarter pounds.

The filter cartridge will require replacement from time to time, the exact time depending largely upon the amount of material which has been deposited and upon the hardness of the water used as the basis for the coolant. The chemical constituents become dissipated in the

reactions of the process and the softening effect of the zeolite is used up. Also, the filter casing of fabric and the sand itself may become somewhat clogged in spite of periodic drainage of the sump.

The mutual interdependence of the chemical, electrochemical, and mechanical filtration actions is important in the present filtering means and in the method by which it functions to clean and maintain clean the coolant and the coolant contact surfaces. A magnesium-iron cell alone would reduce iron oxide formations, but without the complexing of the magnesium ions by other reagents, they would migrate to the iron surface and there deposit the very type of scale formation which it is desired to eliminate. Without the passivating action of a chromate and nitrite, the cell action would cause the reduction of thinly deposited surfaces to metallic iron and the subsequent re-oxidation of the iron to form a loose iron oxide would result. The passivating chemicals alone would soon be dissipated by the reaction of the chromate with valence 3 iron oxide to form water soluble iron chromate. Water softening alone, by the zeolite, would eliminate subsequent scale formations but would, at the same time, stimulate corrosion. It will be apparent, therefore, that the several constituents of the filter and filter cartridge have all been carefully coordinated to bring about a unitary result by their interrelated action.

The reagents which have been specified are preferred, but the invention may be carried out using other chemical compounds. For example, sodium hexametaphosphate may be substituted for sodium tetraphosphate, both being polyphosphates of an alkali metal. Similarly, sodium tungstate can be used in place of sodium chromate, both being alkali oxysalts of group VI metals. Also, sodium phosphite can be used instead of sodium nitrite, both compounds being alkali oxysalts of group V metals existing at lower oxidation states.

While certain preferred embodiments of the structure and proportions of the constituents have been shown and described, these are to be understood to be illustrative only as further changes may be made to meet differing conditions and requirements, and we contemplate such modifications as come within the spirit and scope of the appended claims.

We claim:

1. A filter for use in filtering coolant liquids in contact with ferrous surfaces, comprising a filter housing, a metallic member in the housing, said metallic member being electrically connected to the ferrous material and being formed of a metal high in the electro-chemical series with respect to iron and constituting an anode in contact with the cooling liquid, a filter cartridge supported in the housing whereby fluid passing through the housing passes through the cartridge, said cartridge containing material constituting a mechanical filter and containing film forming reagents including approximately equal parts by weight of sodium nitrite and sodium chromate.

2. A filter as defined in claim 1 further characterized in that the reagents include sodium tetraphosphate.

3. A filter as defined in claim 2 further characterized in that zeolite is included in the filter cartridge.

4. A filter for use in filtering coolant liquids in contact with ferrous surfaces, comprising a filter housing, a metallic member in the housing, said metallic member being electrically connected to the ferrous material and being formed of a metal high in the electro-chemical series with respect to iron and constituting an anode in contact with the cooling liquid, a filter cartridge supported in the housing whereby fluid passing through the housing passes through the cartridge, said cartridge containing material constituting a mechanical filter and containing reagents comprising approximately 10 parts sodium tetraphosphate, 6 parts sodium nitrite, 6 parts sodium chromate and zeolite exceeding in quantity the total other reagents, said parts being measured by weight.

5. A replaceable filter cartridge for use in filtering fluids in contact with different metals including iron and a sacrificial metal higher in the electro-chemical series than iron which comprises a flexible, permeable casing and finely divided material therein, said material comprising substantially insoluble inert material serving as a mechanical filter and a film forming composition consisting essentially of sodium nitrite and sodium chromate in substantially equal parts by weight.

6. A replaceable filter cartridge as defined in claim 5 further characterized in that the material in the casing includes sodium tetraphosphate.

7. A replaceable filter cartridge as defined in claim 5 further characterized in that the material in the casing includes zeolite.

8. A replaceable filter cartridge for use in filtering fluids in contact with different metals including iron and a sacrificial metal higher in the electro-chemical series than iron which comprises a flexible, permeable casing and finely divided material therein, said material comprising substantially insoluble inert material serving as a mechanical filter and a film forming and fluid treating composition including approximately 10 parts sodium tetraphosphate, 6 parts sodium nitrite, 6 parts sodium chromate and zeolite exceeding in quantity the total other reagents, said parts being measured by weight.

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