# BONDING PROCEDURE

## Chemical Bond

This procedure consists of thorough cleaning, careful tinning and control of cooling. The steps in detail for new work are as follows:

1. The shell, either steel or bronze, should be finally machined on the surface, which will be babbitted so as to produce a "phonograph finish." This is done by using a sharp V-shaped tool on the final cut, which is, of course, light and required a fine feed. Polished bright surfaces are to be avoided.

2. No oil or cutting compound of any description can be used during the final machining of the shell. The surface must be clean and free of oil; it should not be wiped with waste.

3. The shell should be removed from the machine and transferred to the tinning department, with a minimum of handling of the surface to be subsequently tinned. Even fingerprints are detrimental to the tinning process.

4. The machined shell is now slowly SUBMERGED in a boiling solution of an alkaline cleaner, such as Wyandotte No. 38 cleaning compound, Oakite, or their equivalent, which will completely remove all traces of dirt, grease and grime. It should remain in this solu-ution for a few minutes or more, depending upon the condition of the shell.

5. Next, the shell is SUBMERGED in a 50-50 hydrochloric acid water solution at a temperature between 160 and 180 degrees F. and etched from 3 to 5 minutes.

6. Upon removing the shell from the acid etch, the surface should be entirely clean and completely wet. It must not shed water at any point. If there are any "islands" or apparent oily surface still remaining, the shell must again be boiled in the alkali cleaning solution and re-etched. It is false to assume that the following flux treatment will correct any imperfections on the surface to be "tinned."

7. The shell is next dipped into a suitable flux, at a temperature approximating 150° F. so that the surface to be "tinned" is completely submerged. The regular zinc-ammonium chloride fluxes will be found satisfactory. The recommended commercial fluxes are "Brucco", made by the Bruce Chemical Co., Cleveland, Ohio or "Grasselli No. 1 Tin Flux" from the Grasselli Chemical Company, or their equivalents.

8. The shell is now ready to be slowly SUBMERGED in a bath containing a suitable "Tinning" alloy. Federated ST-15 Solder, containing 15.0% tin, 1.25% silver, 0.5% bismuth and the balance lead, is recommended in all cases; though alloys containing 10.0% tin, 10.0% antimony, or 4.0% tin, 12.0% antimony, with the balance lead can also be used satisfactorily on steel shells. The temperature of the "tinning" metal is important. It should never be so hot that the "tinned" surface of the shell will oxidize or turn yellow when removed from the pot. The surface should remain bright and clean. Temperatures over 650° F. are likely to prove too hot. If a small area does not successfully "tin", it should be "dressed" by hand. Frequently a simple treatment with sal ammoniac is all that is necessary. If this fails, clean such spots with a wire brush, portable grindstone or other means until the base metal (shell) is free of all dirt, grease or oxides. The local surface is then painted with 50-50 hydrochloric acid water solution and followed by an application of flux, as mentioned above. The surface is then "tinned" with stick "tinning" alloy of the same composition as the metal in the "tinning" pot. If the shell is still hot from the previous operations, no additional heat may be required.

Chemical Bond contd.

9. The shell is now ready for immediate pouring of the babbitt. As soon as the mandrel, preheated to the desired temperature, is in place, the babbitt should be poured. The heat of the shell, plus that of the molten babbitt, will keep the bonding metal in the desired fluid condition as the babbitt fills the mould. This makes for a stronger union between the babbitt and the shell. The pouring of the bearing is vitally important. It should always be done in one continuous pouring operation. If the job is going to take 50 lbs. of babbitt, a ladle holding 50 lbs. of metal must be used. The same holds true if the bearing requires 200 lbs. of babbitt and is necessary in order to prevent the formation of layers in the babbitt face which are caused by interrupted pouring. The ladles should be designed to underpour the metal, or if not so constructed, the dross should be held back with a piece of wood. Finally, the babbitt should be poured so as to produce as little turbulence as possible. The metal should always flow quietly and continuously into the mould until it is full.

10. After the metal has been poured, solidification should progress from the shell toward the mandrel; that is, the first of the babbitt to solidiy should be that at the face of the shell and at the bottom; while the last to solidify should be at the surface of the mandrel and at the top. To accomplish this, the mandrel should be approximately 100° F. hotter than the shell when the mass of metal in the shell and in the mandrel are approximately the same. If the mass of metal in the mandrel is greater than that in the shell and, therefore, cools more slowly, the temperature must be adjusted accordingly. If the bearing is spun, a further refinement in directional solidification can be obtained by use of suitable water sprays, so that the solidification starts at the center of the shell and progresses outward toward both ends.

In re-babbitting work, it may be possible in some cases to shortcut the above procedure. The old bearing metal can be removed by dipping into a bath of metal kept for that specific purpose. (Sweating the metal off with a torch is not recommended.) It may then be necessary to dress the surface with a wire brush to remove any excess of the previous bearing metal, so that the original bonding metal is exposed. Contamination with the old babbitt is to be avoided. If the shell then has a COMPLETE and a THIN coating of the bonding metal and is BRIGHT and CLEAN, it is ready to receive the new babbitt.

If, on the other hand, after the old babbitt has been removed, there remains some portions of the surface which are not properly "tinned", then the shell must be given a thorough cleaning as indicated in number 4 above and subjected to the remaining steps in the process.

Mechanical Bond

This method relies upon dove-tails or anchors and having the babbitt lay tightly against the shell. It is used with certain of the larger bearings and with most cast iron shells, where it is not deemed feasible to attempt to bond chemically. With the machanical bond, the cleaning, etching and fluxing treatments are not required because there is no diffusion between the shell and the babbitt.

The babbitt should be poured and solidification controlled in the same fashion as recommended with the chemical bond. Where the mass of metal in the shell and mandrel is large, excessive cooling time is required and, therefore, they cannot be heated to as high temperatures as desired, unless there is adequate equipment to permit water cooling. The temperature of the shell and mandrel should be such that the babbitt solidifies as quickly as possible, but solidification should start at the bottom and proceed upward and toward the mandrel. In other words, it is most important to have the babbitt metal "feed" in the proper direction during solidification, so that no shrinkage cavities form in the babbitt or at the surface of the shell. It is vital that the shell be shrunk onto the babbitt, in order to insure that the babbitt lay tightly against the shell.

Many bearing failures can be attributed to shrinkage cracks that are formed by the babbitt pulling away from the shell during solidification. These shrinkage cracks cause more cracks to appear when the babbitt is subsequently peened or hammered against the shell by the axle when the bearing is put into service. If the shrinkage cracks are eliminated by the proper feeding of the babbitt when pouring, the bearings will not fail; for when the babbitt lays tightly against the shell, there is combined in the bearing, the strength of the shell and the bearing qualities of the babbitt.