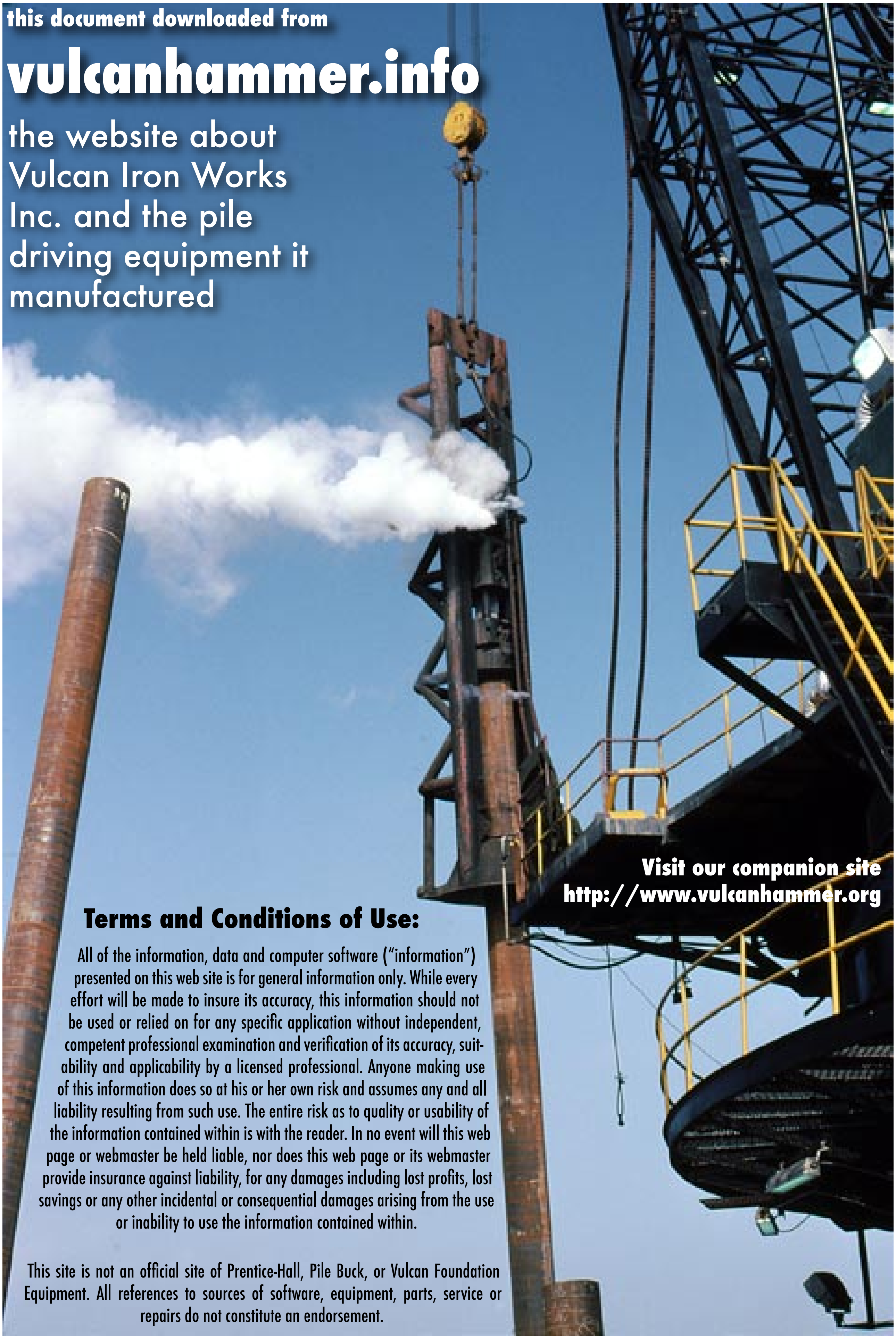

AN INTRODUCTION TO CAPBLOCKS

by George J. Gendron

IN THE normal complement of pile driving tools such as the rig, hammer, capblock and follower, the capblock (sometimes called the cushion block or dolly) is the part most taken for granted. Over the years many pile contractors have come to consider it an expendable item. Many feel that the capblock has to be sacrificed to prolong the life of the hammer and the follower, and to prevent overstressing the pile. The Raymond organization, however, recognized the need for capblock improvement many years ago.

In 1936, in the first of a series of analyses, existing capblocks were evaluated on the basis of: 1) Cost, 2) Elastic properties, and 3) Effect on hammer operation.

The most common capblock assembly used with steam hammers consisted of a cylindrical wooden block, enclosed in a tapered steel sleeve and capped at the top and bottom with steel plates. The block, commonly of oak but sometimes of eucalyptus or greenheart, had a life that varied from several piles per block to several blocks per pile. Considering the cost of capblock material and the labor involved in making a replacement, the total amount of money expended for capblocks each year was appreciable.

The variations in elastic properties and resulting basic inefficiency of existing capblocks was recognized: if piles could be driven with a capblock that was 100% efficient interposed between the hammer and the pile, approximately 85% of the rated energy of the hammer would be available to do useful work. Some modern pile formulae recognize that no "*perfect*" cushion exists and factors are included in the formula to compensate for this inefficiency; these factors assume a certain *constant* loss in the cushion. Wood cushion blocks vary greatly in elastic properties. A brand new capblock can absorb as much as [illegible]5% of the energy of the hammer blow and a block that has been compressed by previous driving can absorb as little

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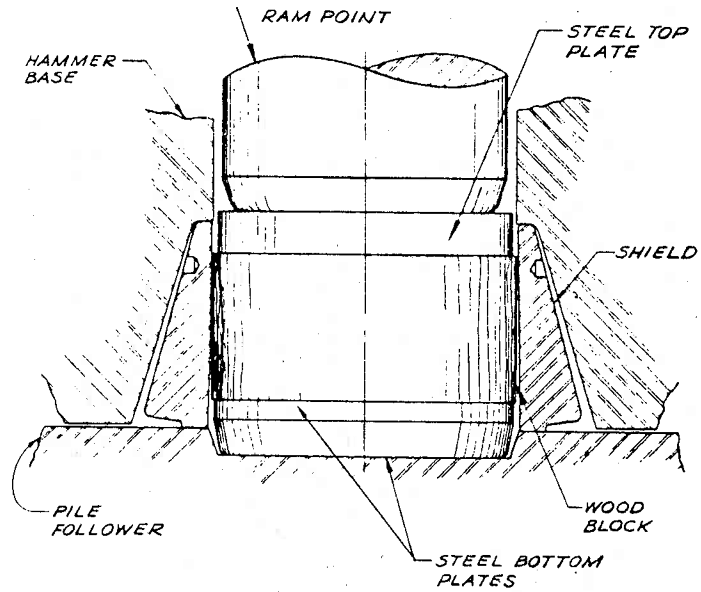
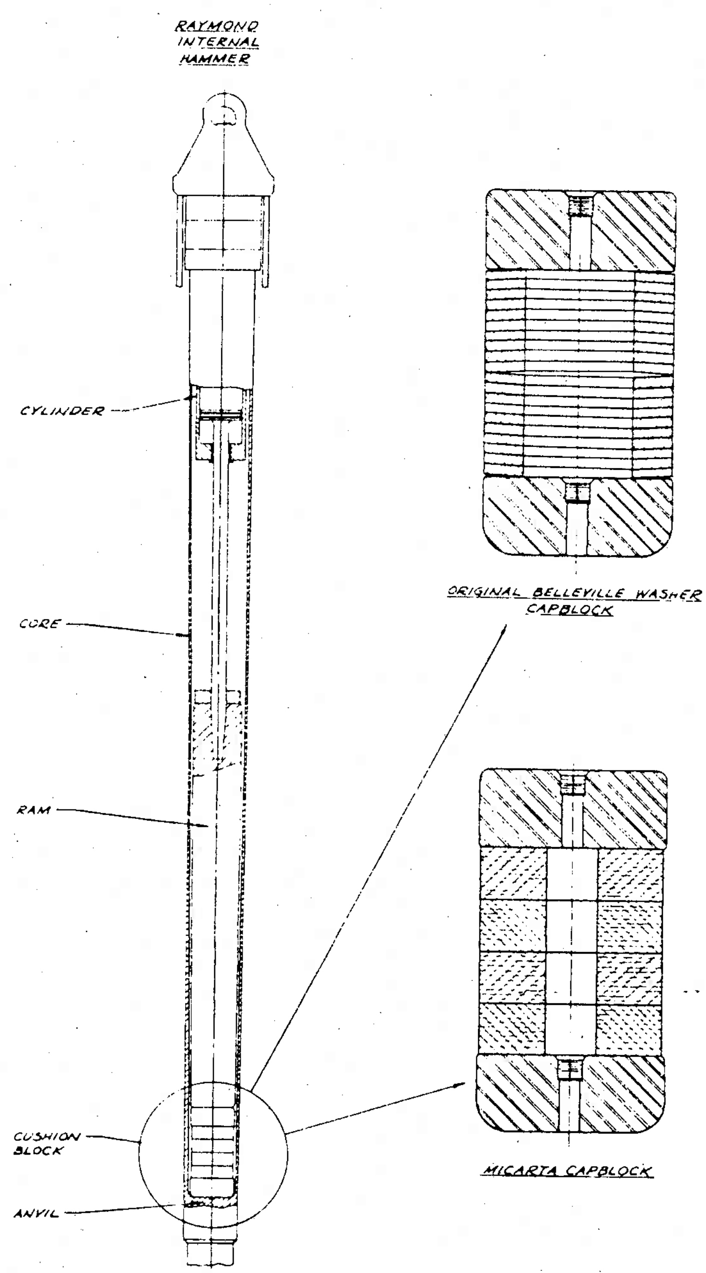


STANDARD WOOD CAPBLOCK ASSEMBLY



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as 20%. Since the estimated load carrying capacity of most piles is computed on the basis of the resistance encountered in the last several inches of driving, the condition of the capblock at this particular time has a direct effect on the factor of safety inherent in any pile formula which utilizes driving resistance in terms of blows per inch as a measure of load carrying capacity.

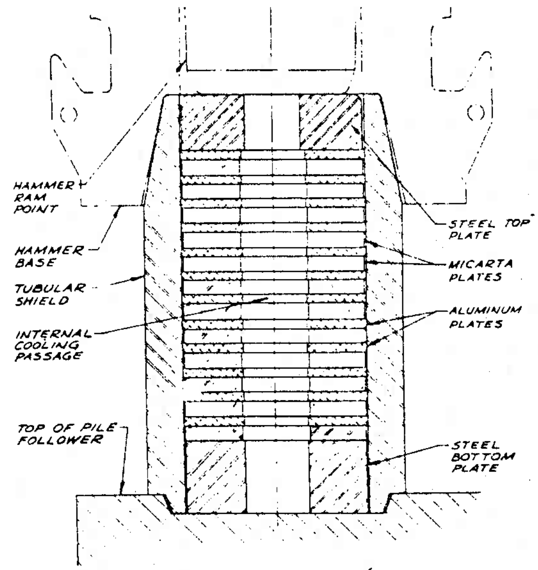
Let us examine the effect of the capblock on the hammer. Steam and air actuated pile hammers are equipped with cam operated valves which translate both motion and position of the hammer ram into valve timing. In order to time a hammer for most efficient operation, it is necessary to actuate the valve at the bottom of the hammer's stroke at the last possible moment. Any wooden capblock presents a variable striking point for the hammer ram. If the hammer valve is timed for maximum efficiency when the block is new, the hammer blow becomes cushioned as the block wears, and the ram has to overcome an upward steam or air force before striking its blow. If the hammer valve is timed to operate with a worn cushion block, its operation with a new or full-height block tends to be sluggish. Because the valve is only partially thrown, the ram raising force and the frequency of blows are reduced and sometimes the hammer stroke is shortened.

Raymond recognized the need for a capblock to improve some or all of these factors more than thirty years ago. Over these years the company has maintained a development program pointed towards continual capblock improvement.

Early experiments were conducted with various types of capblocks, including laminated plywood blocks, rubber, asbestos, and coiled steel cable.

In 1937, experiments with steel spring assemblies indicated some qualified success. A patent was granted in 1938 covering some of the configurations tested.

In 1940 the company's engineers conceived the idea for its internal hammer. This pile driving tool was designed to work inside a step-tapered mandrel and deliver its blow to an anvil buried within the mandrel, rather than on the top (see figure). Because of the inaccessibility of the capblock in this particular design, the need for a more "permanent" type was accentuated. A cushion made of Bellville washer springs was developed which provided the necessary characteristics of: a) Long life; b) Constant striking point; and c) High and predictable efficiency.



STANDARD ALUMINUM/MICARTA CAPBLOCK ASSEMBLY

Unfortunately, the production of Bellville washer springs of the size required for this cushion was more an art than a science. While the desired characteristics could be built into each individual spring and checked at the factory, the life varied from piece to piece. Some springs failed when the first blow was struck and others lasted for tens of thousands of blows. It became necessary to institute a program of "field testing" of individual washers before an assembly of proven springs was available. Even after this field test, the life of a capblock assembly was governed by the individual washer which had the shortest life. Once the first washer broke, pieces of it produced uneven loads on the balance of the springs and they soon failed.

The next stage in the Raymond research and development program was the use of Westinghouse Micarta wafers. This material, with a modulus of elasticity of 560,000 psi and a compressive strength of 35,000 psi, made it possible to fabricate a cushion to take the place of the Bellville springs. The micarta wafer had the required characteristics that development engineers considered important to the success of the program.

The micarta assembly, though it tended to overheat when the number of blows per pile greatly exceeded the average, performed admirably with our 12,000 ft. lb. internal hammer. However, the micarta wafer assembly saw only limited service with 15,000 ft. lb. and larger hammers because of excessive internal heating. All through the 1940's, experiments continued with different wood blocks, various plastics, and even with a hydraulic (water) cushion assembly.

In the late 1940's, with the appearance of the differential steam hammer on the commercial scene, the life of any capblock was seriously shortened. The differential steam hammer virtually doubled the number of blows delivered by a comparable single-acting hammer. The life (in terms of total blows) of the capblock was reduced because of increased hammer frequency for the blows delivered by differential hammers gave little time between blows for the capblock to cool; wood capblocks caught fire and micarta capblocks melted.

A development program was then initiated with a view towards developing a micarta assembly that would remain cool. Experiments were conducted with the capblock submerged in water. Holes were drilled in the retaining shield. Various materials for the shield were tried. The result of this research and development was the Raymond aluminum-micarta capblock assembly. This assembly consists of a stack of alternate disks of aluminum and micarta (phenolic laminate). The micarta furnishes the cushioning. The aluminum conducts any heat generated in the micarta to the outside capblock shield or inner cylindrical air cooling passage.

While the aluminum-micarta capblock has filled most present requirements, experiments continue in search of new capblocks. Experiments have already been conducted with even more permanent type assemblies using compressible fluids. The capblock of the future, as we envision it, will have a life measured in terms of years instead of weeks or months and embody characteristics not only predictable but hopefully adjustable to maximize the efficiency of any hammer/pile combination.