Nov. 15, 1955 E. A. SMITH 2,723,532

PILE DRIVING CAP BLOCK

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Fig. 1.

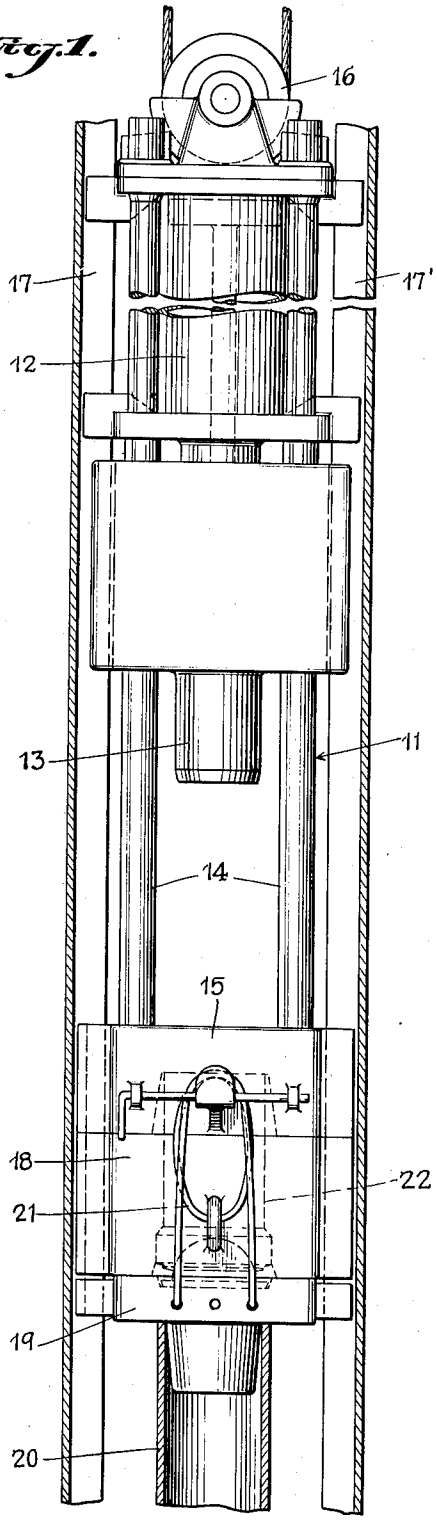
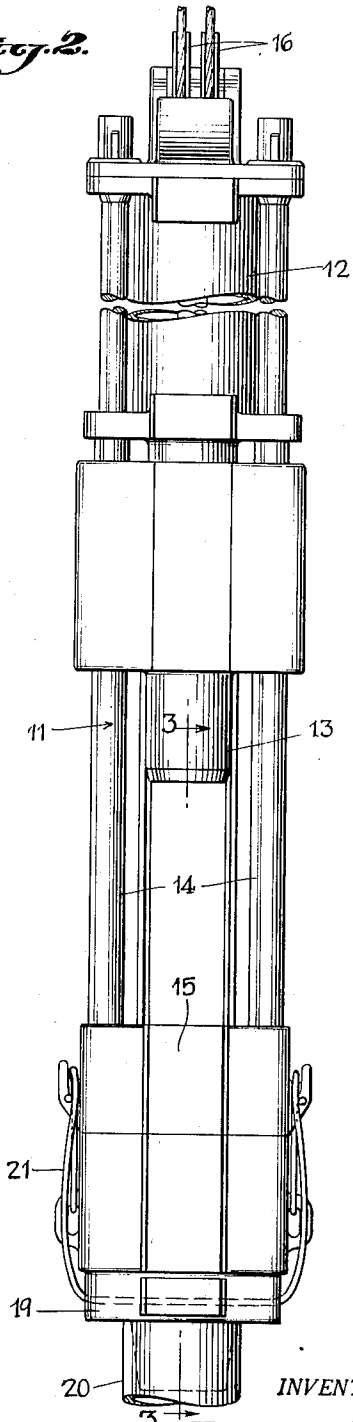


Fig. 2.



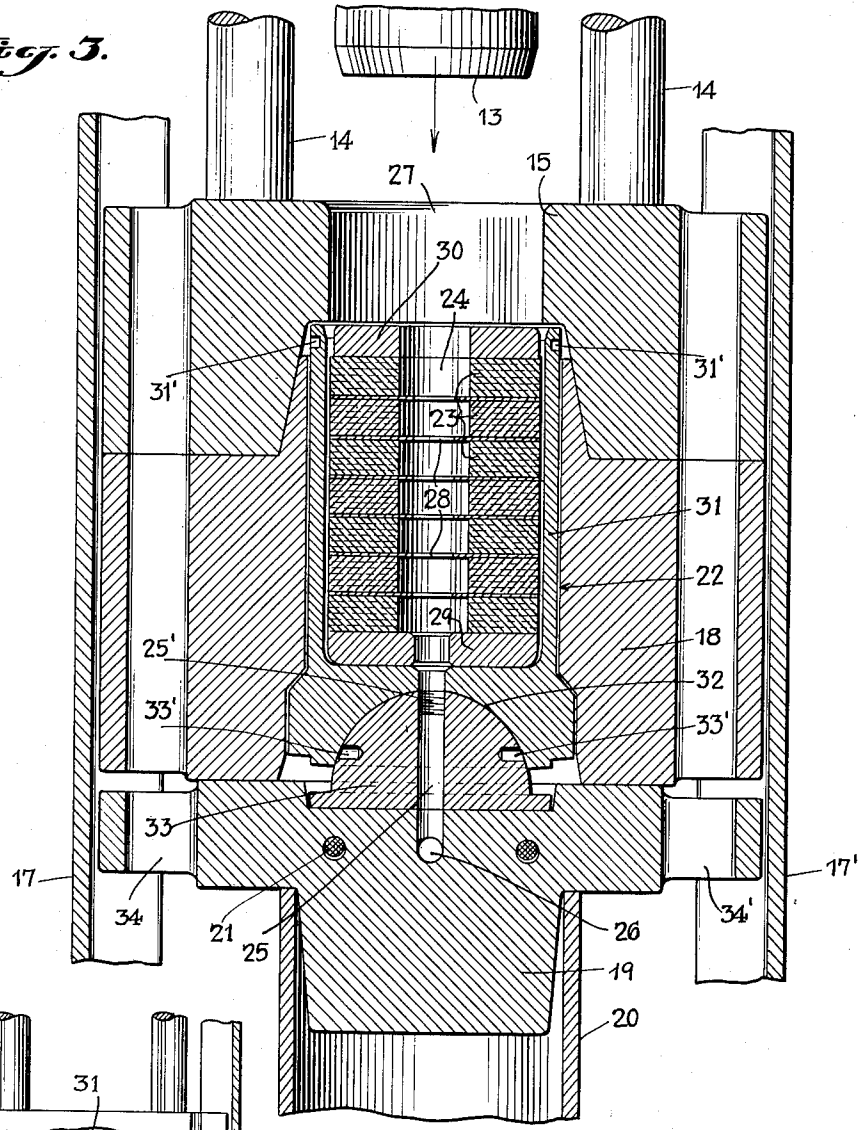
INVENTOR.
EDWARD A. SMITH.
BY
Wald, Crosby & Neal
ATTORNEYS.

Nov. 15, 1955 E. A. SMITH 2,723,532

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Fig. 3.



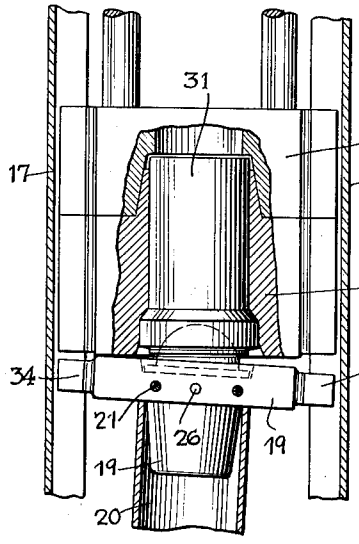


Fig. 4.

INVENTOR.
EDWARD A. SMITH.
BY
Ward, Crosby & Neal
ATTORNEYS.

Nov. 15, 1955 E. A. SMITH 2,723,532

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Fig. 5.

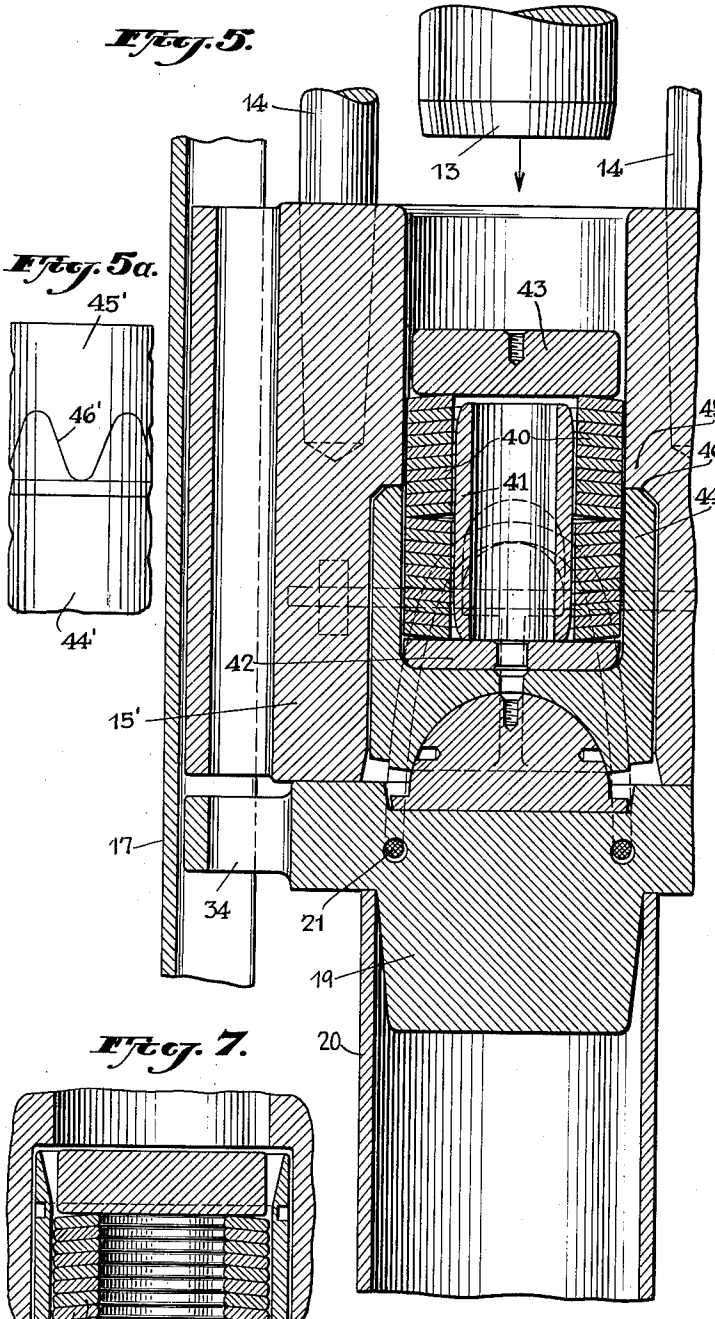


Fig. 5a.

Fig. 6.

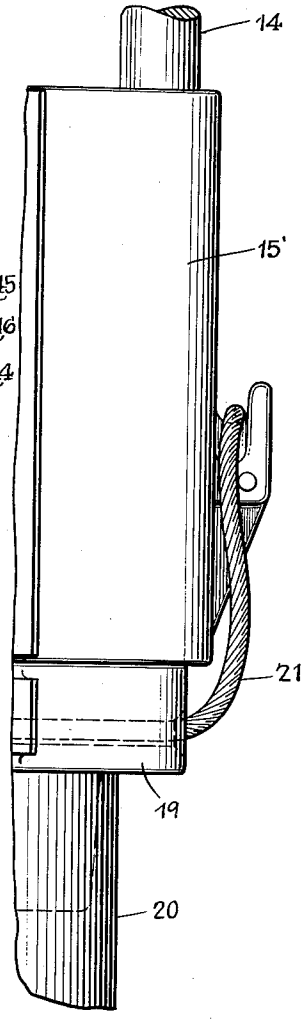


Fig. 7.

Fig. 8.



INVENTOR.
EDWARD A. SMITH.
BY
Ward, Crosby & Neal
ATTORNEYS.

Nov. 15, 1955 E. A. SMITH 2,723,532

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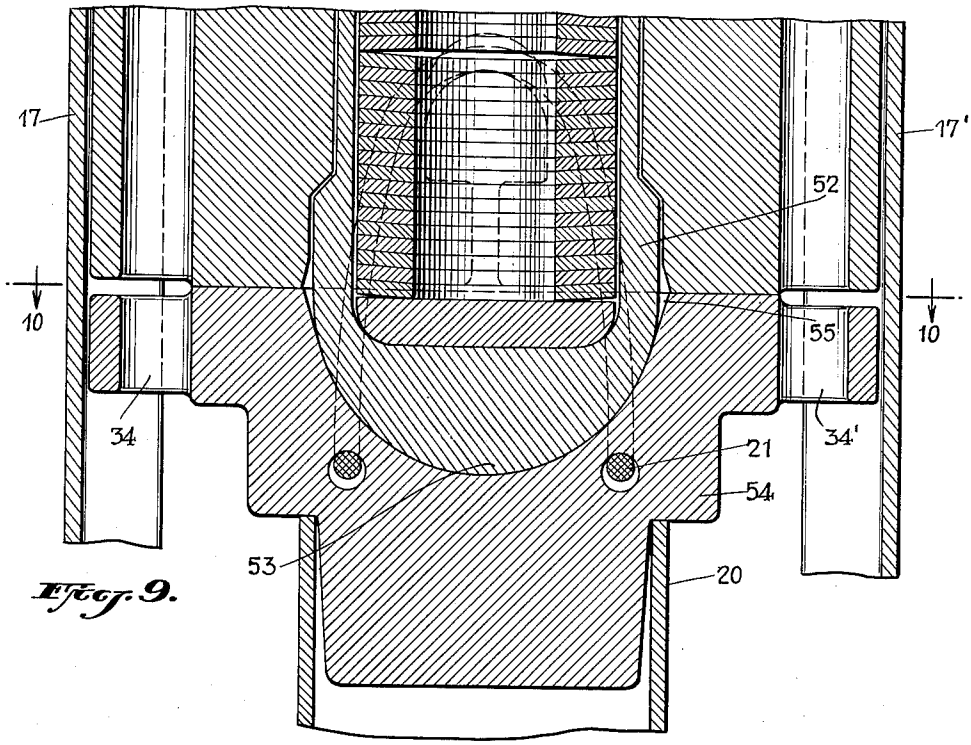
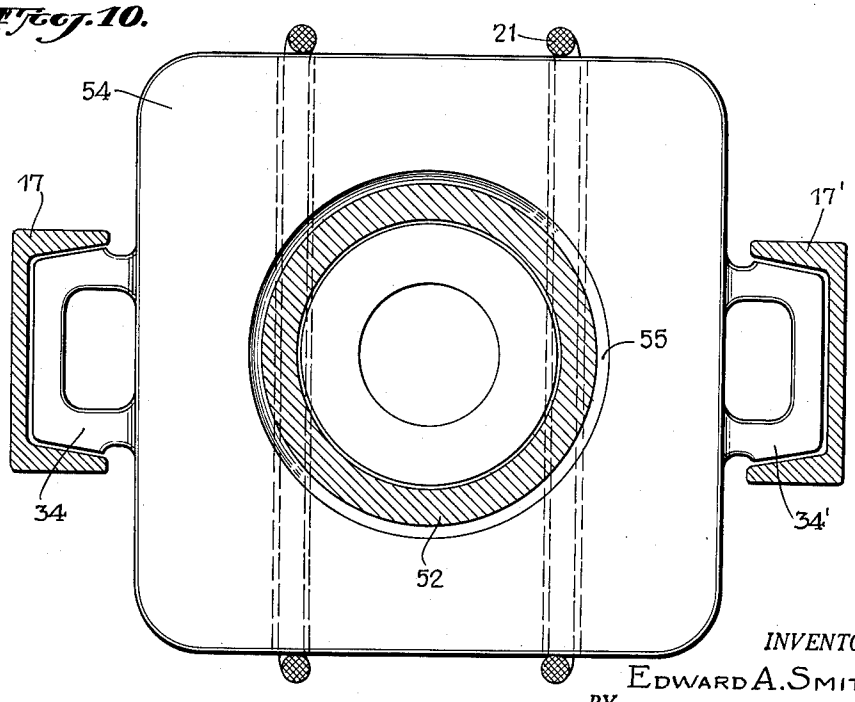


Fig. 9.

Fig. 10.



INVENTOR.
EDWARD A. SMITH.
BY
Ward, Crosby & Neal
ATTORNEYS.

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PILE DRIVING CAP BLOCK

Edward A. Smith, Chatham, N. J., assignor to Raymond Concrete Pile Company, New York, N. Y., a corporation of New Jersey

Application October 19, 1951, Serial No. 252,128

9 Claims. (Cl. 61—77)

This invention relates to apparatus for driving piles and the like, and more particularly to an improved combination and arrangement of cushioning means, or so-called "cap-block" for use between the driving hammer and the pile follower, drive cap, or other part which receives the impacts.

In driving piles, pile shells or cores it has long been a common practice to use as a cushioning means between the hammer and the impact receiving member, a cap-block of wood, contained in a metal ring or shield which prevents the wood from spreading under the blows of the hammer. The wood has the ability not only to absorb and cushion the direct blows but also the ability to crush on one side in case of misalignment, to a sufficient degree so that the blow is transmitted satisfactorily over the entire area of the block, despite the misalignment. Such wooden cap-blocks, however, become so soon compacted and ineffective that they have to be replaced ten to fifteen times during each day while a pile driver is in service. Such replacements require a substantial amount of time during which the expensive pile driving equipment is inactive, so that the most of making such replacements, requiring usually a total of an hour or more per day of pile-driver time, becomes a serious expense.

Another method sometimes used is to provide a similar arrangement, except that the cap-block shield is made as an integral part of the follower which is being driven, instead of being a separate piece, thus forming a receptacle with a closed bottom for receiving the wood. With this arrangement it is possible to use miscellaneous small pieces of wood which from time to time are thrown by an attendant into the shield, at moments when the ram of the hammer is in its upper position. The hammer crushes such wood into a pulp-like mass which serves as the cushioning means, but when such mass becomes so impacted and hard that it has to be replaced, it is an exceedingly difficult and time-consuming task to dig the hard mass out of the shield. Thus also with this alternative arrangement, the cost of replacements and labor become serious factors.

In cases where the hammer can always be held substantially in alignment with the member being driven as, for example, when the hammer is mounted within the upper end of a pile core being driven, the above noted difficulties may be avoided by utilizing the cushioning devices disclosed in the U. S. patent to Kinneman No. 2,184,745, granted December 26, 1939, and wherein a plurality of so-called "Belleville" washers or the like forms the cushioning element. However, in ordinary pile driving where the core or follower and the hammer are two entirely separate pieces or assemblies, which cannot ordinarily be kept in alignment, such devices, in so far as disclosed in said patent, are unsatisfactory because the impacts occur only on one small side area or another of the Belleville washers, depending upon the direction of the misalignment of the hammer and pile.

The present invention provides an improved combination of parts satisfactorily overcoming all of the above

noted difficulties and provides an efficient cap-block arrangement which may be substantially permanently kept in use, or at least which requires replacement only at long intervals and which may be used for pile driving purposes generally, even though the misalignment of the hammer with respect to the pile parts may amount to as much as 10° or more. The invention in various of its embodiments also involves novel and improved forms of cushioning elements, although in certain of its forms the invention may make use of cushioning elements in the form of Belleville washers, as disclosed in said patent.

Further and more specific objects, features and advantages of the invention will appear from the detailed description given below, taken in connection with the accompanying drawings which illustrate by way of example the presently preferred forms of the invention.

In the drawings:

Figs. 1 and 2 are side elevational views taken at right angles to each other and showing a pile driving hammer in assembled relation with an upper portion of a pile, and a follower, the location of the cap block features of the invention being indicated in Fig. 1.

Fig. 3 is a vertical sectional view of one embodiment of the cap-block arrangement and associated parts assembled in accordance with the invention;

Fig. 4 is a view of the parts shown in Fig. 3, partly broken away and indicating the relative positions of the upper portion of a pile shell and its follower when misaligned with respect to the axis of the pile driving hammer;

Fig. 5 is a view similar to Fig. 3 but partly broken away and showing an alternative embodiment of the invention;

Fig. 5*a* is a detail view showing certain parts broken away, forming an alternative feature of the invention;

Fig. 6 is a side view partly broken away showing further portions of the assembly of Fig. 5;

Fig. 7 is a detailed vertical sectional view of a further alternative embodiment of certain parts of the assembly;

Fig. 8 is a sectional view of a preferred form of Belleville washer for use in the embodiments of Figs. 5 and 7;

Fig. 9 is a view similar to the lower part of Fig. 3 but showing a further embodiment; and

Fig. 10 is a horizontal sectional view taken substantially along line **10—10** of Fig. 9.

Referring to the drawings in further detail, a pile driving hammer of a known type is indicated generally at **11** having a cylinder portion at **12** and ram means at **13** reciprocable vertically along rods **14** to which a base portion **15** is secured. The hammer is adjustably suspended from cable and pulley means **16** so as to slide between the pile driver hammer guide ways or so-called leads **17**, **17'**.

As shown, the hammer may have a supplemental base portion **18** beneath which is located a so-called follower **19** which receives the hammer blows and imparts same to a pile, pile shell or the like **20**. The follower may be loosely connected to the hammer base by a known form of removable sling means as at **21**.

The location in the assembly of the cap block and associated parts to which this invention more particularly relates, is indicated by the dotted lines at **22** in Fig. 1.

Referring now to Fig. 3, the cap block assembly of the embodiment here shown comprises a stack of annular washer-like members as at **23** formed of thermoset laminated synthetic resinous material which may be of a known type, such for example as a material commercially known under the trademark "Bakelite-Micarta." Such materials have a modulus elasticity of only about 560,000, which is approximately 1/60 that of steel, yet they have an ultimate compressive strength of some 35,000 pounds per square inch, or about half that of steel. Thus materials of this type have been

found to be surprisingly desirable for the purpose, in that they provide a springy and yet very strong material able to withstand repeated heavy blows for a long time without cracking or objectionable deformation. However, if a cap block made of such materials is to be able readily to withstand the temperatures which will occur therein when used with modern heavy double-acting types of pile driving hammers which deliver blows very rapidly, then provision should be made for ventilating or otherwise cooling the resinous material. This is accomplished in the form here shown by providing the resinous elements in annular form with a central cavity 24, communicating with a cavity as at 25 through the parts below and thence to the atmosphere through a horizontal outlet as at 26. With such cavities the ram, upon entering the cavity 27 in the base of the hammer, acts as a reciprocating pump to pump on each stroke a blast of cooling air down through the cap block assembly. And if further cooling action is found desirable, the resinous elements may be interspaced with annular sheet metal discs as at 28, the inner portions of which protrude into the cavity 24 to form in effect cooling fins for conducting heat from the resinous bodies into the cavity 24.

Preferably the stack of resinous elements is supported on an annular metal member 29 and surmounted by another similar metal member 30 which receives the blows from the ram 13 and the whole assembly is contained in a cup-like cap-block shield 31, which in turn is received within cavities of suitable shape and form in the base members 15 and 18. Incidentally, it may be here noted that if desired the base portions 15 and 18 may be made integral, although for reasons of convenience, in the particular example shown in Fig. 3, these parts were made as two separate elements having partially telescoping portions.

The lower portion of the cap block shield is formed with a cavity 32 which conforms in shape to the surface of a sphere having its center substantially at the center line of the hammer, viz. on the line of the axis of the ram with which the cap block assembly itself is also coaxial. The cavity 32 is adapted to receive a member 33, the upper surface of which is complementary with the cavity 32. That is, the member 33 provides a surface conforming to a sphere having the same geometrical center as the cavity 32, so that if the pile shell or the like 20 (as is often the case) becomes misaligned with the hammer, as indicated in Fig. 4, then the follower 19 together with the member 33 will be free to turn about the geometrical center of the spherical surfaces whereby the blows of the ram will still be applied through the cap-block assembly uniformly over all parts of the cross-section of the latter, and such blows will be transmitted by the cap-block through the follower without concentrating the pressure on any part of the cap-block cross-section to a greater degree than at other parts. Thus destructive pressures concentrated in any particular part of the cap-block will be avoided.

In order readily to remove the cap-block assembly as contained in the shield 31, small holes as at 31' may be provided near the upper edge of this member to receive a tongs-like tool for lifting out the assembly when the hammer base 15 is removed. Similarly, for removing and handling the member 33, same may be provided with small holes as at 33'. Also, if desired the cavity 25 on this member may be threaded as at 25' to receive a suitably threaded tool for lifting the member 33.

The follower 19 as per known constructions, has its upper part formed to act like a cross-head, and includes oppositely directed arms 34, 34' for slidably engaging the pile driver leads 17, 17' respectively. Such slidable engagement with the leads is ordinarily made with sufficient clearance so that (as indicated in Fig. 4) considerable leeway is available for permitting misalignment of the pile with respect to the hammer without jamming of the parts. And in order that the hemispherical surface on member 33 will not be materially thrown toward one side or the other, and thus tend to jam the parts upon misalignment of the pile, the center point for such hemispherical surface (as well as the center point for the surface of cavity 32) should preferably be at or close to the level of the arms 34, 34'.

In the form of the invention shown in Fig. 5, the various parts as shown are generally similar to those of Fig. 3, except that the hammer base 15' is formed as one integral member and the cap block assembly per se comprises a stack of Belleville washers 40 preferably surrounding a central thimble 41. These washers are supported on a metal disc 42 and surmounted by a heavier metal disc 43 for receiving the blows. Also with this embodiment, the cap block shield is preferably formed of two portions, viz. a lower part 44 and an upper portion 45 which preferably is integrally formed with the hammer base 15'. That is, the cavity in the hammer base has an internal flange formation at 46 to normally abut the upper edge of part 44. The purpose of this arrangement and of the central thimble 41 when used, is to retain the Belleville washers from jumping out of place following each blow. That is, after a blow is struck on the assembly causing the follower and pile to advance downwardly, the washers (or at least the upper ones) may tend to jump up out of place and into edgewise positions or otherwise so that the next blow may cause destructive jamming or cracking of one or more of the washers. The thimble member 41 provides an internal means for retaining the stack of washers in position and the separation of the cap block shield structure at flange 46 permits the shield portion 44 to travel downwardly upon receiving a blow while the portion 45 remains stationary with respect to the hammer as a part of its base and thus remains in a position extending above the stack of washers thereby confining same externally against jumping out of place. As shown in Fig. 5a, the cap-block shield portions 44', 45' may be separated by a sinuous line gap 46' (or a gap of some other suitable varying form) so that there will be no free gap here through which one or more of the washers might slip sideways, even though a thimble (such as at 41) is not used. Portion 45' may either be made integral with the hammer base 15' or as a separate thimble-like member tightly fitting in the cavity of the hammer base.

The construction and operation of the other parts of Fig. 5 will be readily apparent from the above description of Fig. 3.

When Belleville type washers are used for this purpose, after considerable use there is a tendency for cracks to occur starting at the corners of the metal, if such corners are made of right-angular cross-section and if one or more of the washers cracks apart, then the next blow may destroy others. To minimize such effects, as shown in Fig. 8, the washers 50 are preferably made with rounded corner portions as at 51 and portions of a stack of washers of this type are indicated in Fig. 7. Such rounded corner portions also minimize the danger that the washers will catch in some position out or their proper seating arrangement when they jump as the result of each impact.

The embodiment of the invention shown in Figs. 9 and 10 is similar to that above described in connection with Fig. 5, except that here the cap block shield member 52, instead of having an upwardly extending hemispherical cavity in its base, is formed with a downwardly protruding hemispherical surface 53 and the follower 54 is formed with the complementary cavity conforming to the surface of a sphere having its geometrical center (as above explained) at the center line or axis of the hammer and substantially at the level of the aligned follower arms 34, 34'. In order to permit the follower to tilt as required to accommodate various positions of misalignment of the piles, without binding and jam-

ming against the member 52, the cavity in the follower around its upper peripheral portions as at 55 should be enlarged somewhat beyond what it would be if it were confined to the surface of a sphere.

It will be apparent that in all of the above-described forms of the invention, there is provided what may be generally referred to as "ball and socket means" beneath the cap block and coaxial therewith and with the ram, for imparting the impacts to the piles or the like when at various positions of misalignment, and for the purposes explained.

Although certain particular embodiments of the invention are herein disclosed for purposes of explanation, various further modifications thereof, after study of this specification, will be apparent to those skilled in the art to which the invention pertains. Reference should accordingly be had to the appended claims in determining the scope of the invention.

What is claimed and desired to be secured by Letters Patent is:

1. In pile driving apparatus including a fluid pressure operated hammer having a base portion and a ram reciprocable therein, the combination comprising a cap block assembly in said base beneath the ram and including a stack of superposed resilient elements, cap block retaining means, a follower beneath said retaining means, said follower having a cross-head like portion including oppositely directed arms for slidably engaging the pile driver leads, said follower and means having complementary engaging surfaces which conform to the surface of a hemisphere having its center normally substantially on the center line of said ram and at a point normally substantially at the level of said arms.

2. The combination comprising resilient cap-block means for receiving the impacts from a pile driver hammer, ball and socket means beneath said cap-block means and through which the impacts may be imparted to a pile or the like when at various angular positions of misalignment with the cap-block means, oppositely directed means extending to each side from said ball and socket means for slidably engaging the leads of a pile driver, the center point of said ball and socket means being located along the line of the axis of the cap block means and normally substantially at the level of said oppositely directed means.

3. A cap-block for receiving the blows from a hammer ram in pile driving apparatus, comprising a stack of superposed resilient synthetic resinous elements, and means for supporting same at the base of the hammer, said stack and supporting means having communicating cavities providing a passage extending vertically through the stack and down through the supporting means to permit blasts of cooling air to be forced therethrough by the ram.

4. A cap-block for receiving the blows from a hammer ram in pile driving apparatus, comprising a stack of superposed resilient synthetic resinous elements interspaced with metal elements, a cavity extending down through said stack of elements to permit blasts of cooling air to be forced therethrough by the ram, said metal elements protruding into said cavity to provide means for radiating heat from the resinous elements into such air blasts.

5. A cap-block for receiving the blows from a hammer ram in pile driving apparatus, comprising a stack of superposed resilient synthetic resinous elements, a metal element on which said stack rests, and another metal element surmounting said stack, all of said elements being formed with communicating central apertures to provide a cavity extending generally vertically through the assembly to permit blasts of cooling air to be forced therethrough by the ram.

6. In pile driving apparatus including a fluid pressure operated hammer having a base portion and a ram reciprocable therein, the combination comprising a cap block means in said base beneath the ram and including a stack of thermoset laminated synthetic resinous elements having a low modulus of elasticity and of high ultimate compressive strength capable without breakage or permanent deformation of uniformly cushioning repeated heavy blows of the ram for the driving of many piles, and means for maintaining said cap block means in such relationship to the upper end of a pile structure that the force of the ram blows will be transmitted through the cap block to such structure without concentrating the pressure on any part of the cap block cross section to any substantially greater degree than at other parts.

7. In combination with a pile driving hammer having a base, a cap block contained in said base, a reciprocable ram positioned to apply blows to said cap block, said cap block comprising a stack of thermoset laminated synthetic resinous plate elements of high ultimate compressive strength and having a modulus of elasticity of several hundred thousand (lbs. per sq. in.) means for retaining said elements in flatwise superposed relation and supporting such stack at the base of the hammer.

8. In pile driving apparatus including a fluid-pressure operated hammer having a base portion and a ram reciprocable into and from a generally vertical cavity in such base portion, the combination comprising a cap block assembly received in such cavity and including a stack of superposed plates of elastic material, said plates each having apertures therethrough and the base of said cavity being formed with an outlet passage communicating with said apertures and normally with the atmosphere, whereby said ram also acts as a reciprocating pump member, to pump on each stroke of the ram, a blast of cooling air down through such cap block assembly.

9. In pile driving apparatus including a fluid-pressure operated hammer having a base portion and a ram reciprocable into and from a generally vertical cavity in such base portion, the combination comprising a cap block assembly received in such cavity and including a stack of superposed thermoset laminated synthetic resinous plates of high ultimate compressive strength and low modulus of elasticity, said plates each having apertures therethrough and the base of said cavity being formed with an outlet passage communicating with said apertures, whereby said ram also acts as a reciprocating pump member, to pump on each stroke of the ram, a blast of cooling air down through such cap block assembly.

References Cited in the file of this patent

UNITED STATES PATENTS

873,517	De Witt	Dec. 10, 1907
1,178,143	Evans	Apr. 4, 1916
1,595,267	Upson	Aug. 10, 1926
2,184,745	Kinneman	Dec. 26, 1939
2,214,295	De Biasi	Sept. 10, 1940
2,295,489	Riemenschneider	Sept. 8, 1942