April 30, 1946. G. N. COLE 2,399,468

ENGINE CYLINDER AND HEAD CONNECTION

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Fig. 2.

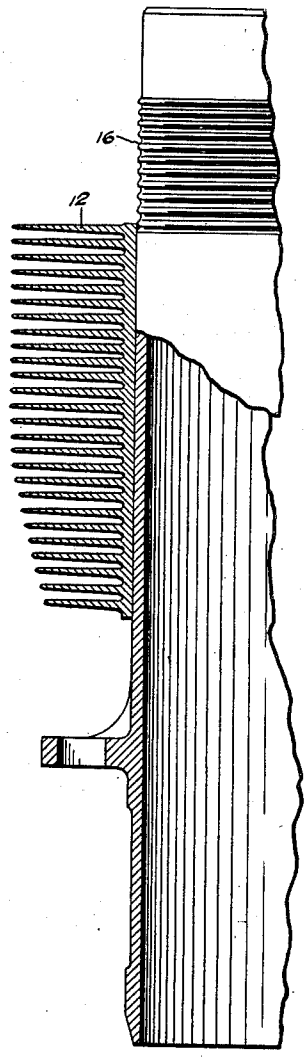
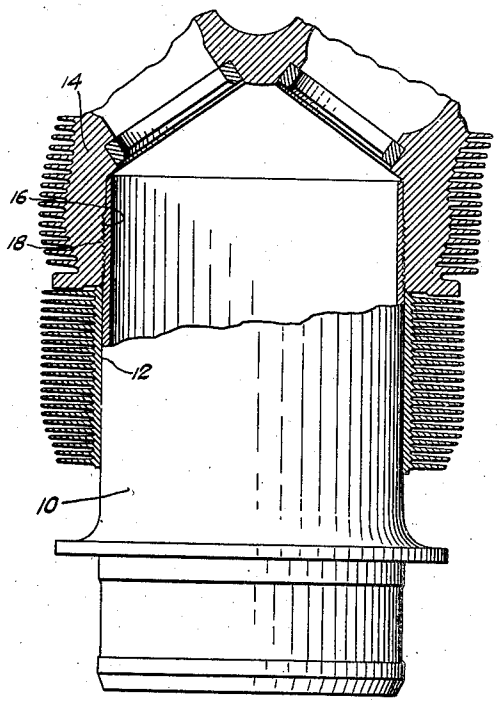


Fig. 1.



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Fig. 3.

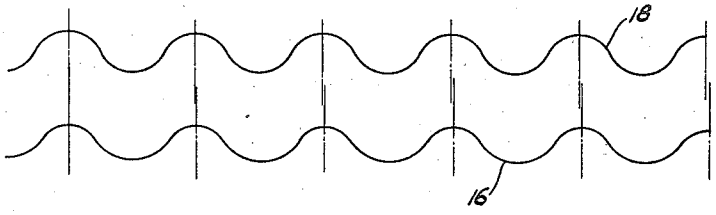


Fig. 4.

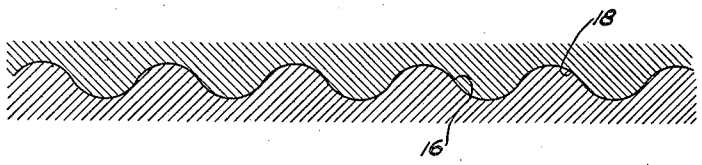


Fig. 5.

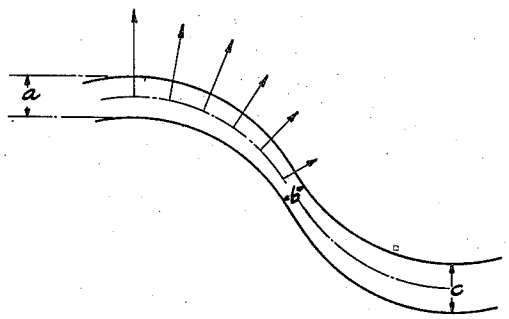
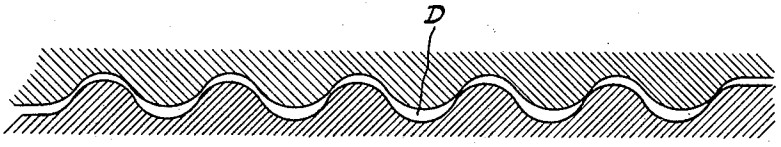


Fig. 6.



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ENGINE CYLINDER AND HEAD CONNECTION

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Application October 30, 1942, Serial No. 463,889

10 Claims. (Cl. 123—193)

This invention relates to a threaded connection.

An object of this invention is to provide an improved threaded connection for a cylinder and cylinder head, particularly of the type wherein the parts are additionally secured by a shrink fit.

Other objects and advantages deriving from this invention will be apparent from the description and drawings herein. It is to be expressly understood that said description and drawings are for the purpose of illustrating a preferred embodiment only and that the invention is not to be limited thereby, reference being made to the appended claims for this purpose.

In the drawings:

Fig. 1 is a front view, partly in section, of a cylinder, fin muff, and cylinder head assembly provided with my improved threaded connection.

Fig. 2 is an enlarged elevational view, partly in section, showing a fin muff placed on the cylinder barrel of Fig. 1, preparatory to threading a cylinder head thereon.

Fig. 3 is a schematic view showing the pitch difference in the threads at the machining temperature.

Fig. 4 is an enlarged sectional view of a portion of the connected members, after completion of the assembly.

Fig. 5 is a stress diagram showing the stress distribution in the connected members.

Fig. 6 is an enlarged sectional view showing interference areas between the threads for obtaining a desirable stress distribution.

In a threaded connection between a cylinder head and a cylinder barrel it is desirable that the external diameter of the barrel threads be kept substantially equal to the external diameter of the muff receiving portion of the barrel, so that the muff may be slipped over the threads to its working position. As the weakest portion of the cylinder barrel is usually at the root of the barrel threads it is also desirable to keep the root diameter of the barrel threads as large as possible and to limit the stress concentration, particularly in tension, at this point. The threads in the head portion of the connection should also be of such form as to reduce stress concentration and tensile stresses, particularly as such heads are usually made of an aluminum base metal which is weak in tension as compared to a steel cylinder barrel.

In the embodiment of my invention shown on the accompanying drawings these and other considerations have been provided for as follows:

The external diameter of the barrel threads 16 is preferably made such that a fin muff jacket section 12 may be passed thereover, as shown in Figs. 1 and 2. My thread form is made of rounded or of sinuous cross-section (see Fig. 4), with no stress concentrating notches or sharp angles such as are present in conventional threads. Compared with a conventional V-thread of like strength, the thread depth is small, so as to permit increase of the barrel thickness at the thread root.

In shrink fits for head and cylinder members having conventional threads, such as a V-thread, tensile forces are set up in the material at the root of each thread. Apparently the thread of one member acts as a wedge tending to tear the material at the thread root of the other member. This action is accentuated in ordinary threaded cylinder head connections by the difference in expansion coefficients of the two materials, usually aluminum and steel. In prior practice, where the parts are machined to have equal pitches at a room temperature which is considerably lower than their working temperature the pitches of the two threads will tend to be different at working temperature. Hence there will be a resulting deformation in the thread material at working temperature resulting in an unfavorable stress at a time when maximum strength is desired.

In my improved threaded connection I have obviated this difficulty as follows. The rounded thread form referred to above reduces stress concentration. The threads 16 and 18 are machined to have slightly different pitches at room temperature, as clearly shown in Fig. 3. This pitch difference is so chosen that when the male and female parts are at their normal operating temperatures the two pitches will be substantially equal, because of the unequal temperature expansion coefficients of the two materials. The engine operating temperature is the temperature at which the maximum strength is required in the connection, and my invention provides such a desirable condition and insures lower tensile stresses by the provision of mating threads having substantially equal pitches at such temperatures. In practice, the temperatures and materials are usually such that the female pitch is as much greater than the male pitch at the shrinking temperatures as it was smaller than the male pitch at the machining or room temperature.

As a further provision against unnecessary tensile stresses in the connected parts, I provide a

thread form of unequal curvatures in the two parts. In other words the radii of curvature of the thread crests and roots of one member are not the same as the radii of curvature of the crests and roots of the other member. Of course, when the parts are assembled with a shrink fit they will meet along a single curved plane, as shown in Fig. 4, the mismatched thread portions being deformed as the two parts are forced into continuous engagement by the forces of the interference or shrink fit. Figure 6 shows, on an exaggerated scale, the interference areas, (D), which represent metal which would overlap if not deformed during assembly, or, in other words, the relative amounts of deformation that must take place as the parts cool and shrink together to form the completed joint of Fig. 4, after being threaded together while the relative sizes of the parts are changed by a change in their relative temperatures, for instance by heating the female member and cooling the male member. It will be noted that the interference areas or interference fit, and consequently the amount of deformation in the material of the parts, is greater at the crests and roots of the threads than at the sides thereof.

As a result of this provision, the stresses in the material are concentrated mainly adjacent the crests and roots of the threads, where the direction of stress is generally normal to the plane of the connection and results in compression in the material. Because the interference areas are less at the sides or flanks of the thread the resulting stresses at this point, which are generally axially directed, are substantially less than the stresses at the crests and roots. The tensile or "tearing" stress in the material is therefore considerably less in a cylinder thread according to my invention than in a conventional thread of like strength.

Fig. 5 is a stress distribution diagram roughly showing the relative magnitudes and directions of some of the stresses that would be set up in a connection like that of Fig. 4, where the relative interference areas, or deformation of the threaded material, is as shown in Fig. 6. It will be seen that the stresses adjacent the crests and roots of the threads, which are generally normal to the pitch line, are large in comparison to the stresses near the pitch line lying more nearly in the direction of the pitch line. The dimensions *a*, *b*, and *c* represent relatively the interference areas or amount of deformation that would occur at different portions of the threads upon assembly thereof.

As a refinement of my connection I may provide that the interference dimension represented by *a* of Fig. 5 is less than the interference area represented by *c*. Where the small dimension *a* is at the root of the aluminum head and the crest of the steel cylinder then this difference in interference areas at *a* and *c* has the effect of relatively lessening the stress at the root of the weaker (aluminum) thread, thus distributing the stress concentration in relation to the strength of the parts.

It is to be understood that the invention is not limited to the specific embodiment herein illustrated and described, but may be used in other ways without departure from its spirit as defined by the following claims.

I claim:

1. In a threaded connection for an engine cylinder head and cylinder barrel, a screw thread on said head, a cooperating screw thread on said barrel, and means providing a desirable stress distribution in said connected parts comprising, interference areas between said barrel threads and said head threads causing deformation and stress in the material of said members upon connection thereof, said interference areas being greater at the crests and roots of the threads than at the sides thereof.

2. In a threaded connection for an engine cylinder head and cylinder barrel, a screw thread on said head, a cooperating screw thread on said barrel, and means providing a desirable stress distribution in said connected parts comprising, interference areas between said barrel threads and said head threads causing deformation and stress in the material of said members upon connection thereof, said interference areas being greater at the crests and roots of the threads than at the sides thereof, the interference area between the thread crest of one member and the thread root of the other member being less than the interference area between the thread root of said one member and the thread crest of said other member.

3. In an engine, a cylinder barrel, a cylinder head having a shrink fit with said barrel, a threaded connection having a sinuous longitudinal cross-section between said barrel and said head, the threads of said connection being proportioned to provide a relatively greater clearance at the sides than at the crests and roots thereof when the relative sizes of the head and barrel are changed by a temperature difference for assembly purposes, whereby the stresses set up in the material of the parts by said shrink fit will be largely directed normal to said connection.

4. In an engine cylinder, a head member shrunk on a barrel member, and a threaded connection between said barrel and said head, said head and said barrel having respectively different coefficients of temperature expansion, the respective thread pitches of the two members being machined to be different at room temperature and being so selected in relation to the respective coefficients of temperature expansion of said members as to be approximately equal at a temperature within the range of cylinder operating temperatures.

5. In an engine, a cylinder barrel, a cylinder head having a shrink fit with said barrel, a threaded connection having a sinuous longitudinal cross section between said barrel and said head, the threads of said connection being proportioned to provide relatively greater clearance, when said head is enlarged sufficiently to assemble the two members by a temperature difference relative to said barrel, at the sides of said threads than at the crests and roots thereof, said head and barrel having respectively different coefficients of temperature expansion, and the respective pitches of the threads on the head and the barrel being machined to be different when said head and barrel are at room temperature and to be approximately equal when said head and barrel are at a temperature within the range of cylinder operating temperatures.

6. In a method of making a shrunk or threaded connection between members having materially different coefficients of temperature expansion and which are subjected to separating stresses at an operating temperature considerably in excess of room temperature, the steps of; machining threads of respectively different predetermined pitches at room temperature on said members, with the thread of greater pitch on the member having the lower coefficient of temperature ex-

pansion, changing the relative temperatures of said members to shrinking temperatures at which the thread whose pitch is relatively larger at room temperature has a pitch which is relatively smaller at said shrinking temperatures, and at which the member having the higher coefficient of temperature expansion is at a temperature higher than said operating temperature, and threading said members together at said changed relative temperatures, the respective thread pitches of said members being so selected in relation to the respective coefficients of temperature expansion of said members that said respective pitches are approximately equal when each of said members is at said operating temperature.

7. A method of making an aircraft engine cylinder which is subjected to rapidly varying stresses at operating temperatures which are considerably greater than room temperature, comprising, machining threads of predetermined different pitches at room temperature on a cylinder head and on a cylinder barrel which have different coefficients of temperature expansion, said thread pitches being so related to the coefficients of expansion of said head and barrel as to be approximately equal when said head and barrel are at said operating temperatures, and threading and shrinking said head and barrel together.

8. A threaded connection for aircraft engine parts which are threaded together while the relative sizes of the parts are changed by a change in their relative temperatures and which are subjected to separating stresses at operating temperatures which are considerably different from room temperature, comprising, threaded male and female engine parts having different coefficients of temperature expansion, said parts having respective threads formed with different predetermined pitches at room temperature with the thread pitches being so related to the coefficients of expansion of said parts that said pitches are approximately equal when said parts are at said operating temperatures.

9. A threaded connection for aircraft engine parts which are threaded together while the relative sizes of the parts are changed by a change in their relative temperatures and which are subjected to separating stresses at operating temperatures which are considerably different from room temperature, comprising, threaded male and female engine parts having respective threads relatively proportioned to provide an interference fit between said threads with the maximum interference occurring between a thread crest on one of said parts and a thread root on the other of said parts.

10. A threaded connection for aircraft engine parts which are threaded together while the relative sizes of the parts are changed by a change in their relative temperatures and which are subjected to separating stresses at operating temperatures which are considerably different from room temperature, comprising, threaded male and female engine parts having different coefficients of temperature expansion, said parts having respective threads proportioned to provide an interference fit between at least one thread crest and the corresponding thread root, the pitches of said threads being selected in relation to the coefficients of temperature expansion of said parts so that said pitches are approximately equal at said operating temperatures.

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