March 26, 1940. D. A. WALLACE 2,195,049

LAPPING APPARATUS

Original Filed Nov. 16, 1936

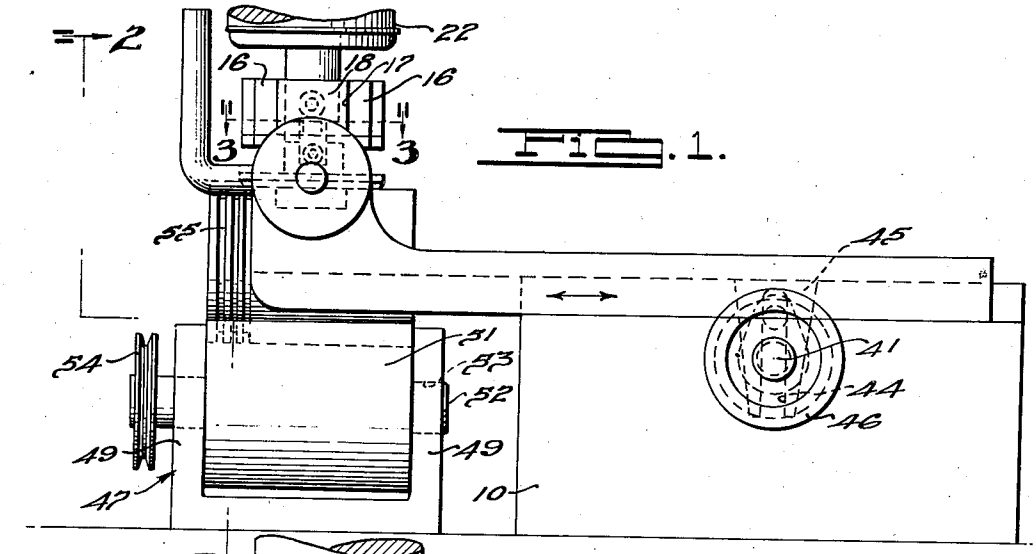

FIG. 1.

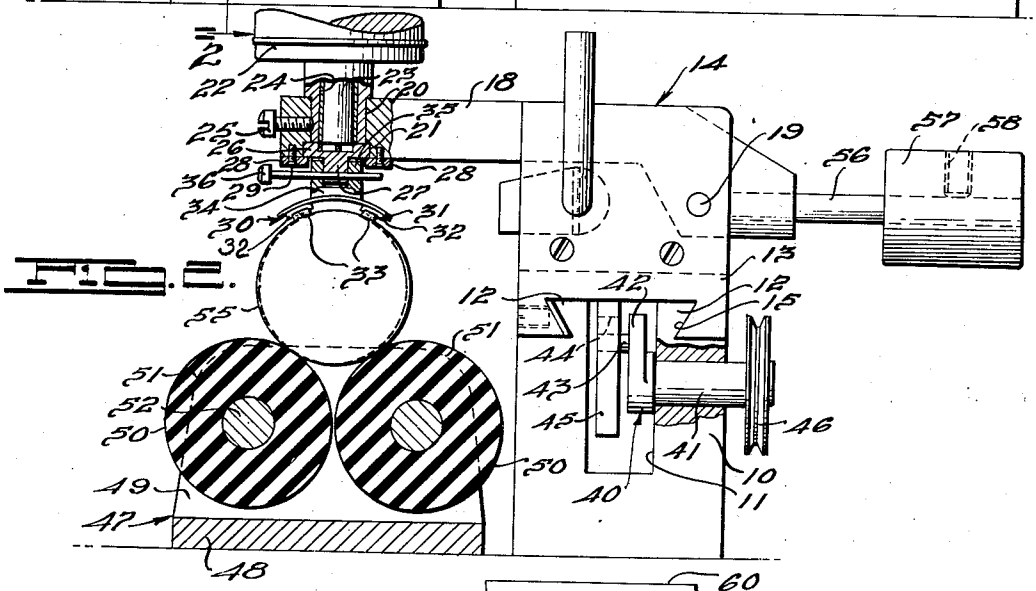

FIG. 2.

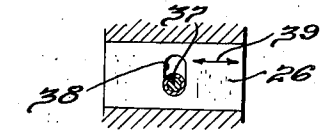

FIG. 3.

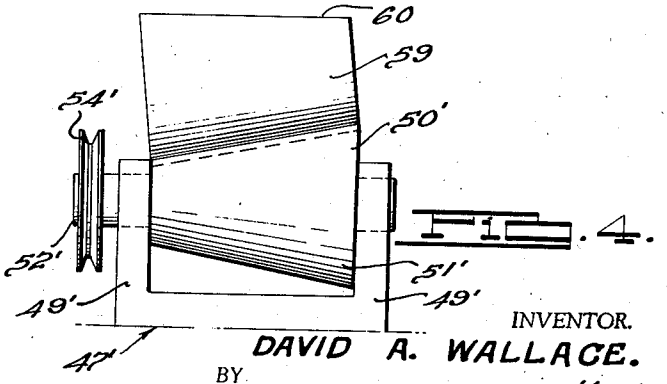

FIG. 4.

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LAPPING APPARATUS

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15 Claims. (Cl. 51—59)

This invention relates to an improved apparatus for lapping surfaces and is a further development of the invention disclosed in my co-pending application Serial No. 91,851 filed July 22, 1936.

More particularly, the invention pertains to lapping of surfaces of apparatus and parts thereof which operate in rubbing, sliding or rotative bearing-like, or frictional contact with other parts.

One of the main objects of the invention is to provide between an article being lapped and a lapping element, a relative movement which is a resultant of a plurality of different simultaneous component movements of the lapping element and the work respectively.

Another object of the invention is to produce relative movement of this character between a lapping element and a surface being lapped which is the resultant of so many components that even during repeated application of the lapping element to the work surface, no isolated area or particle of the lapping element will be repeatedly applied to the same increment of area of the work.

A further object of the invention is to provide apparatus for so moving portions of a lapping element from one group of machine-formed ridges of a surface to be lapped to another, during rapid reciprocation of the element, that the accumulated lapped off material and parts of the lapping element which normally tend to foul the working surface thereof are freshly dislodged before advancement of the lapping element to unlapped ridges or ridges in a different stage of the lapping process.

Other objects of the invention are to provide an apparatus for rotating a piece of work while a surface thereof is in lapping engagement with the lapping element and simultaneously reciprocating the lapping element throughout a relatively short stroke at a rate substantially of a vibratory order while also translating the lapping element throughout a longer stroke at a lower speed of movement; to provide lapping elements of relatively small dimensions and correspondingly light weight in lapping apparatus of this character which are susceptible of convenient reciprocation at high velocity; to provide means for translating such lapping elements while they are reciprocating, into lapping engagement with successively adjacent portions of a piece of work of substantially greater dimensions than the dimensions of the lapping element; and to provide lapping element translating mechanism of this character which reciprocates the lapping element throughout a predetermined stroke at one rate of speed while they are also reciprocated at a different rate of speed throughout a different length of stroke.

Additional objects of the invention are to provide improved means for rotating a piece of work while it is in operative engagement with the lapping element; to provide means of this character which yieldably supports and holds the work in operative engagement with the lapping element; to provide work supporting and rotating mechanism in apparatus of this kind which will accommodate and properly condition noncylindrical surfaces of irregular articles for the reception of lapping operations of the foregoing character; to provide work holding means of this kind which frictionally rotates the work and which does not require that the work be centered or otherwise conditioned for imparting thereto rotative movement; and to provide work supporting and rotating apparatus of this character which will properly position and rotate conical and frusto-conical surfaces of pieces of work to be operated upon in accordance with the improved lapping method.

Illustrative embodiments of the invention are shown in the accompanying drawing, in which:

Fig. 1 is a fragmentary side elevational view of a lapping apparatus embodying the invention.

Fig. 2 is a fragmentary vertical sectional view taken on the line 2—2 of Fig. 1.

Fig. 3 is a fragmentary horizontal sectional view taken on the line 3—3 of Fig. 1.

Fig. 4 is a fragmentary side elevational view of a portion of the apparatus illustrated in Fig. 1 showing a further development thereof.

In the form of the invention illustrated in Figs. 1, 2 and 3, my improved lapping apparatus comprises a base portion or support 10 having a longitudinally extending channel 11 provided with an open upper extremity at the top side of the support. Formed on the upper side of the support 10, along the lateral edge portions of the channel 11, is a dovetailed rib 12 on which the carriage 13 of a lapping tool, generally designated by the numeral 14, is slidably mounted. The tool carriage 13 is provided with a dovetailed groove 15 for receiving the dovetail rib 12, as illustrated in Fig. 2. The tool carriage 13 has an upwardly extending bifurcated end comprising spaced flanges 16 between which a groove 17 is provided. The tool 14 includes a lever 18 which is disposed in the groove 17 and pivotally supported on the upstanding flanges 16 by a pin 19. Formed in the left end of the lever 18, as viewed

in Fig. 2, is a bore 20 which communicates with a rectangularly shaped recess 21 formed in the lower side of the left end portion of the lever 18. Mounted in the bore 20 is a tubular extension of a casing of an electric motor 22 or other suitable driving means, having a shaft 23 journaled in a bearing 24 carried by the tubular motor casing extension. The motor 22 is securely held in place on the lever 18 by a set screw 25 or other suitable means. Slidably mounted in the recess 21 is a block 26 having an apertured lug 27 extending downwardly from its lower side. The block 26 is held against displacement from the recess 21 by cleats 28 having edge portions extending inwardly beyond the edges of the recess and secured to the lower side of the lever 18 by screws 29.

Pivotally mounted on the apertured lug 27 is a lapping element carrier 30, preferably comprising a strip of yieldable and resilient sheet metal 31, on which are attached spaced lapping element brackets 32 of channel-shaped cross section. Lapping elements 33, preferably comprising stones, are securely held in the channel-shaped brackets 32. The lapping elements 33 may comprise natural stone, or artificially compressed blocks of lapping material or any other suitable lapping substances. A pivotal coupling member 34 having spaced apertured ears 35 between which the apertured lug 27 is receivable, is provided on the upper side of the resilient sheet metal plate 31 for pivotally attaching the lapping element carrier to the slidable block 26. The apertured lug 27 and apertured ears 35 are pivotally and detachably connected together by a removable pin 36 which extends through the apertured lug 27 and ears 35, as illustrated in Fig. 2, the foregoing lapping element mounting and reciprocating mechanism being similar to that shown in my co-pending application, Serial No. 91,851.

Lapping elements 33 may be drivingly reciprocated by the motor 22 by means of an operative connection between the motor shaft 23 and the slidable block 26 which is provided by a pin 37 eccentrically mounted on the lower extremity of the motor shaft 23 and operatively engaged in an elongated slot 38 formed in and extending transversely of the slide block 26. During rotation of the motor shaft 23, the slide block 26 is reciprocated at a relatively high speed approaching a speed of a vibratory order and in the directions illustrated by the arrow 39 in Fig. 3. The stroke of the reciprocatory movement produced by the motor 22 is relatively short but during reciprocation of the lapping elements 33 by the motor the entire tool 14 is reciprocated bodily by the sliding movement accommodated by the dovetail connection between the support 10 and the tool carriage 13.

Continuous bodily reciprocation of the tool throughout a substantially greater length of strokes than that produced by the motor 22 is provided by driving means associated with the support 10 and comprising a crank, generally designated by the numeral 40 in Fig. 2. The crank 40 has a bearing portion 41 journaled in an aperture formed in the support 10 and a crank throw 42 located in the channel 11. Formed on the crank throw 42 is a laterally extending crank pin 43 which is engaged in a substantially vertical notch 44 formed in a downwardly extending flange 45 carried by the lower side of the tool carriage 13, as illustrated in Fig. 1. The bearing portion 41 has an end part located externally of the support 10 on which is mounted a pulley 46 which may be drivingly connected by a belt or other suitable means (not shown) to a motor (not shown) or other suitable driving means.

By the foregoing apparatus, the lapping elements 33 are reciprocated at a relatively high speed throughout a comparatively short stroke while they also undergo reciprocatory movement of a comparatively longer stroke and at a relatively slower speed. During such reciprocatory movements of the lapping elements 33, they may be applied to the surface to be lapped of an article which is rotatively supported, and preferably drivingly rotated by any suitable supporting and rotating means.

In the form illustrated in Figs. 1 to 3, inclusive, the work supporting and rotating means, generally designated by the numeral 47, comprises a metal base having a substantially horizontal plate 48 provided with spaced upstanding flanges 49 at its respectively opposite ends. Rotatably mounted between the flanges 49 are adjacent rollers 50 having spaced peripheral portions 51 preferably comprising non-metallic yieldable material having frictional properties, such as rubber. Each peripheral portion is carried by and preferably bonded to a central shaft 52. Opposite end portions of each shaft 52 are journaled in apertures 53 formed in the end flanges 49 of the base plate 48 and one of the shafts 52 extends beyond one end flange 49 and is provided with the pulley 54 by which one roller 50 is directly driven.

A piece of work to be lapped is disposed so as to be mutually supported by both rollers 50 while it is operated upon by the lapping elements 33. In the illustration shown in Figs. 1 and 2, a piston 55 is disclosed in operative lapping engagement between the rollers 50 and the lapping elements 33. The piston 55 may, as shown in Fig. 2, be of slightly elliptical or out-of-round contour. During rotation of one of the rollers 50, the work 55 is also rotated and in turn drives the other roller 50. If desired, the rollers may be drivingly connected together by suitable gearing (not shown) including an idler pinion by which the rotative drive may be imparted directly from one roller to another while still maintaining rotation of the rollers in the same direction.

The lapping tool 14 may be rotated in a counterclockwise direction, as viewed in Fig. 2, about the pivot 19 in order to accommodate removal of work from and placement thereof on the yieldable supporting rollers 50. In order to predetermine the pressure applied on the work by the lapping element 33, the lever 18 of the lapping tool 14 is provided with a stem 56 which extends from the right end of the lever 18, as viewed in Fig. 2. Adjustably mounted on the stem 56 is a counter-balance weight 57 which may be releasably held in an adjusted position by a set screw 58. The balance weight 57 is adjustably positioned so as to counter-balance all but a desired portion of the moment of the motor and portion of lever 18 on the right hand side of the pivot 19 in order to predetermine the force by which the lapping elements 33 are applied to the surface operated upon.

In the form of the invention illustrated in Fig. 4, there is provided a pair of frusto-conical shaped rollers 50' each comprising an outer yieldable peripheral portion 51' formed of non-metallic, yieldable, frictional material, preferably comprising rubber, and a central shaft 52'. Each

shaft 52' is rotatably journaled in apertures formed in upstanding flanges 49' of a base structure, generally designated by the numeral 47'. The peripheries 51' of the rollers 50' are preferably spaced apart and one of the shafts 52' is provided with a pulley 54', or other suitable means, by which one of the rollers may be directly drivingly rotated. The rollers 50' are arranged in adjacent relationship in the manner illustrated in Fig. 2 and they are adapted to mutually support a frusto-conical shaped piece of work 59 as shown in Fig. 4. The frusto-conical rollers 50' may be mutually directly driven by gear mechanism (not shown) including an idler gear interposed therebetween in order to drive both rollers in the same direction. In the form shown, however, the rotatively driven roller rotates the work and the latter, in turn, rotates the other roller. The inclinations of the sides of the rollers 50' are preferably so predetermined with respect to the inclinations of the sides of the work 59 as to bring the uppermost extremity thereof, represented by the line 60 in Fig. 4, into a substantially horizontal position in order that the surface of the work may be properly presented to the lapping elements 33.

By virtue of the foregoing lapping apparatus and method the relative movement produced between the work and the lapping element is a resultant of a plurality of different components which assures removal of the machining formed ridges of the surface operating upon without producing scratches by repeatedly bringing isolated portions, or hard particles of the lapping surface of the lapping element into repeated engagement with the same increment of area of the work. Relatively small and light lapping elements may be used upon work having surfaces of much greater dimension while assuring equal application of the lapping elements to all portions of the work surface. This is accomplished by not only reciprocating the lapping elements relative to the lapping tool, but by bodily reciprocating the lapping tool through substantially long strokes at a comparatively slow speed. The combined reciprocations of the lapping elements at relatively high speed throughout a comparatively short stroke, assures removal of metal and particles of the lapping element from between the grains of the latter at its working surface and thereby maintains the working surface of a lapping element in a clean and efficient cutting condition.

The yieldable work supporting and rotating apparatus facilitates rapid and ready removal of work from the machine and placement of work thereon and accommodates articles of non-cylindrical shape. By frictionally driving the work in the foregoing manner, the requirements of centering the work is dispensed with as well as are the hazards of injuring the work during mounting thereof for rotation about a fixed center. By yieldably supporting the work in this manner, the surfaces of out-of-round articles, such as elliptical pistons, may be lapped to a high degree of smoothness substantially without varying their dimensions and contours and particularly without excessively removing metal from those portions of the work which are located at greatest distance from its central axis.

Although several specific embodiments of the invention are herein shown and described, it will be understood that various changes in the size, shape and arrangement of parts may be made without departing from the spirit of my invention.

What I claim is:

1. Lapping apparatus comprising a support, means adjacent said support for rotatably supporting a piece of work, a lapping tool shiftably mounted on said support for movement in the general direction of the axis of said work including a main body part having an end portion adjacent said work and a reciprocable lapping element and holder assembly, said assembly constituting only a small portion of the mass of said tool and being movable in said direction relatively to said lapping tool and engageable with said work, mechanism for rotating said work and reciprocating said tool bodily relative to said support at a comparative slow speed, and driving mechanism on said tool for reciprocating said lapping element relative thereto at a substantially faster rate of speed.

2. Lapping apparatus comprising a support, means adjacent said support for rotatably supporting a piece of work, a lapping tool including a body portion shiftably mounted on said support and a lapping element and holder assembly, said assembly being many times lighter in weight than the main body portion of said tool and being reciprocable relative to said body portion in a direction substantially parallel to the rotative axis of said work at a speed of a vibratory order and said lapping element being engageable with said work, a driving member on said tool constructed and arranged to reciprocate said lapping element relative to said tool body portion throughout a relatively short stroke and at a comparatively high speed of a vibratory order, mechanism for rotating said work, and apparatus for reciprocating said tool bodily relative to said support throughout a substantially longer stroke and at a comparatively slower rate of speed.

3. Lapping apparatus comprising a support and having a guide member thereon, means adjacent said support for rotatably supporting a piece of work, a lapping tool having a body portion shiftably mounted at one end on said support and confined by said guide member to shifting movements in a path substantially parallel to the rotative axis of said work and having an opposite end portion extending over said work, said tool comprising a lapping element reciprocably mounted on the latter end portion of said body portion, and means for confining the reciprocating movement of said lapping to a path substantially parallel to said axis, a driving member on said tool constructed and arranged to reciprocate said lapping element relative thereto throughout a relatively short stroke and at a comparatively high speed, mechanism for rotating said work, and apparatus for reciprocating said tool bodily relative to said support throughout a substantially longer stroke and at a comparatively slower rate of speed.

4. Lapping apparatus comprising a support, means adjacent said support for rotatably supporting a piece of work, a tool carrier shiftably mounted on said support, a lapping tool pivotally mounted on said tool carrier having an end portion registering with work supported by said means, a lapping element reciprocably mounted on said end portion of said tool and engageable with work supported by said means, a driving member mounted on said end portion of said tool for reciprocating said lapping element and urging the same toward said work, and mecha-

nism for driving said work rotating means and reciprocating said tool bodily relative to said support.

5. Lapping apparatus comprising a support, means adjacent said support for rotatably supporting a piece of work, a tool carrier shiftably mounted on said support, a lapping tool pivotally mounted on said tool carrier having an end portion registering with work supported by said means, a lapping element reciprocably mounted on said end portion of said tool and engageable with work supported by said means, a driving member mounted on said end portion of said tool for reciprocating said lapping element and urging the same toward said work, mechanism for driving said work rotating means and reciprocating said tool bodily relative to said support, and means carried by said tool on the opposite side of the axis of the pivotal mounting thereof from that on which said lapping element is located for counterbalancing selected portions of the weight of said driving member to predetermine the pressure of application of said lapping element upon said work.

6. Lapping apparatus including means for yieldably supporting and frictionally rotating a piece of work, a lapping tool comprising a lapping element reciprocably mounted thereon and adapted to bear upon and urge work supported by said means toward the latter, and mechanism for driving said means to rotate said work and for drivingly reciprocating said lapping element respectively.

7. Lapping apparatus including means for yieldably supporting and frictionally rotating a piece of work, a lapping tool comprising a lapping element adapted to bear upon and urge work supported by said means toward the latter, and mechanism for driving said means to rotate said work.

8. Lapping apparatus including means for yieldably supporting and frictionally rotating a piece of work having generally circular cross sections by engagement with the surface of said work to be lapped, a lapping tool adjacent said means having a lapping element engageable with said surface and adapted to bear thereon in the direction of said yieldable supporting means, and mechanism for driving said means to rotate said work.

9. Lapping apparatus including means for yieldably supporting and frictionally rotating a piece of work having generally circular cross sections by engagement with the surface of said work to be lapped, a lapping tool adjacent said means having a reciprocable lapping element engageable with said surface and adapted to bear thereon in the direction of said yieldable supporting means, a member on said tool for drivingly reciprocating said lapping element while the latter is in engagement with said surface, and mechanism for driving said means to simultaneously rotate said work.

10. Lapping apparatus including means for yieldably supporting and frictionally rotating a piece of work comprising a pair of adjacent rollers having yieldable peripheral portions between portions of which said work is receivable, a support adjacent said means, a lapping tool carried by said support and comprising a lapping element engageable with said work and adapted to bear thereon in the direction of said means, and mechanism for driving said rollers to rotate said work.

11. Lapping apparatus including means for yieldably supporting and frictionally rotating a piece of work comprising a pair of adjacent rollers having yieldable peripheral portions between portions of which said work is receivable, a support adjacent said means, a lapping tool carried by said support and comprising a reciprocable lapping element engageable with said work and adapted to bear thereon in the direction of said means, a member mounted on said tool for drivingly reciprocating said lapping element, and mechanism for driving said rollers to rotate said work.

12. Lapping apparatus including means for yieldably supporting and frictionally rotating conical and frusto-conical articles comprising a pair of frusto-conical rolls having yieldable peripheral portions, said rolls being so constructed as to bring the periphery of one of said articles into substantially parallel relationship with respect to said rolls at the side of said articles remote from said rolls when said article is supported thereon, a lapping tool comprising a lapping element reciprocably mounted thereon and confined for reciprocation in directions substantially parallel to the axis of said rolls, said lapping element being engageable with the portions of the periphery of said article which are substantially parallel with said axis, and mechanism for simultaneously drivingly reciprocating said lapping element and rotating said article.

13. Lapping apparatus comprising a support, means adjacent said support for rotatably supporting a piece of work, a lapping tool shiftably mounted on said support including a main body portion and a lapping element and holder assembly, said lapping element being engageable with said work and said assembly constituting only a substantially small portion of said tool as compared to said main body portion and being reciprocable relative to said main body portion in a direction substantially parallel to the axis of said work, and apparatus for drivingly rotating said work, reciprocating said lapping element assembly relative to said main body portion of said tool and reciprocating said tool relative to said support simultaneously.

14. Lapping apparatus comprising a support and having a guide member thereon, means adjacent said support for rotatably suporting a piece of work, a lapping tool shiftably mounted on said support and confined by said guide member to shifting movements in a path substantially parallel to the rotative axis of said work, said tool comprising a main body portion and a lapping element and holder assembly, said assembly constituting only a substantially small portion of the mass of said tool as compared to the main body portion thereof and being reciprocable relative thereto in a path substantially parallel to said axis, and separate and independent driving mechanisms for individually drivingly rotating said work, reciprocating said lapping element relative to said main body portion of said tool and reciprocating said tool relative to said support respectively.

15. Centerless lapping apparatus comprising a support, a tool carrier member mounted on said support, a work supporting member adjacent said support including a roll for rotatably supporting and frictionally rotating a piece of work, a lever mounted at one end portion of said tool carrier member and having an end portion registering with said work, said registering end portion of said lever having a lapping element and holder assembly reciprocably mounted thereon, said lapping element and holder assembly comprising a

relatively small mass as compared to the mass of said lever and tool carrier member, said lapping element being engageable with work supported by said work supporting member, said work supporting and tool carrying members being relatively reciprocable, a driving member for producing relative reciprocation of said members, means entirely independent of said driving member for drivingly reciprocating said lapping element relatively to said tool carrier member, and mechanism entirely independent of said aforesaid driving means and member for drivingly rotating said roll to rotate said work.

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