March 23, 1954 L. L. VASOLD 2,673,273

DISTRIBUTOR BREAKER ARM

Filed Jan. 26, 1948

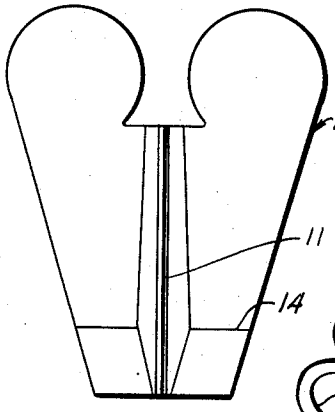

FIG. I

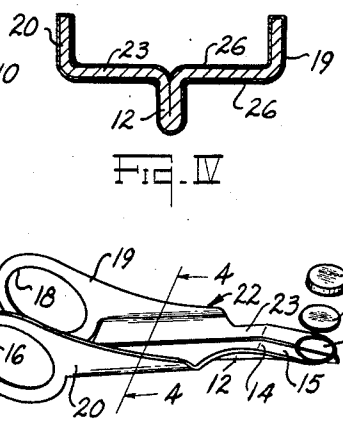

FIG. III

FIG. IV

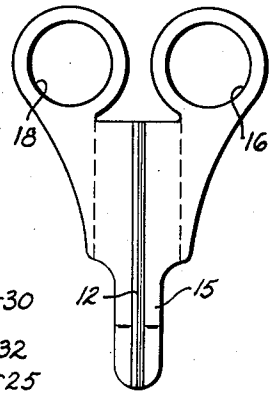

FIG. II

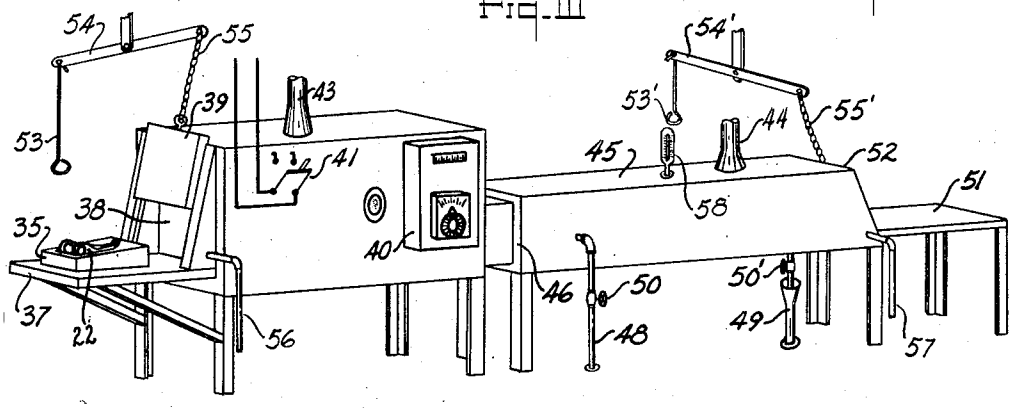

FIG. V

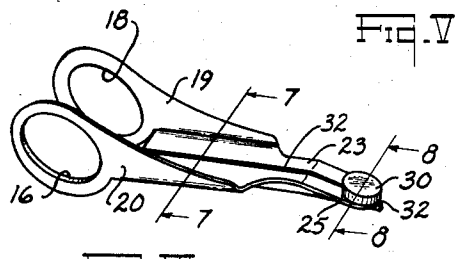

FIG. VI

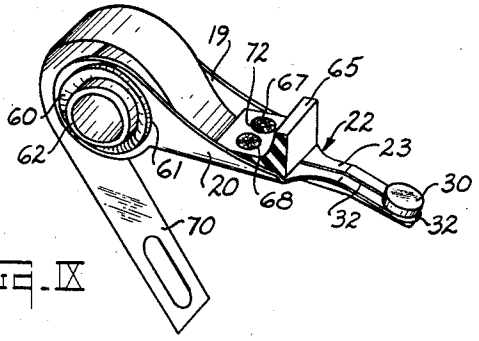

FIG. IX

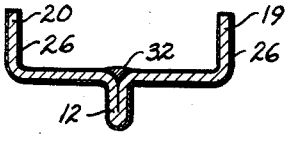

FIG. VII

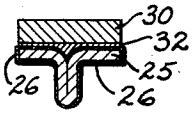

FIG. VIII

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2,673,273

UNITED STATES PATENT OFFICE

2,673,273

DISTRIBUTOR BREAKER ARM

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Application January 26, 1948, Serial No. 4,391

8 Claims. (Cl. 200—166)

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The present invention relates to electrical circuit interrupters of the make-and-break impact contact type adapted to be used as timers for ignition apparatus or breaker arm contact units on ignition systems for engines and relates particularly to the structural formation and method or process of producing the same.

The invention includes the production of an electrical make-and-break contact or breaker arm unit, for a system using a periodic interrupter, made of a very thin ferrous metal, to which is bonded or intimately joined a tungsten or other suitable contact, the unit provided with sufficient ductility and tensile strength to withstand, without substantial deformation or bending, highly recurrent impacts and which has a very high fatigue strength and a long life of efficient functioning without material failure in operation.

The invention comprehends the structural formation of a breaker contact lever unit for ignition devices for automotive type engines which operates in a very efficient manner at particularly high speeds for considerable periods of time and is capable of withstanding, without deformation or rupture failure, the highly recurrent longitudinal and transverse stresses which occur at high speed, lasting at least five times as long as the conventional breaker contact levers used under similar conditions.

The invention comprises an improved means and process or method by which a lever arm of a ferrous metal and its contact member are very effectively bonded or brazed and concurrently heat-treated, to secure a predetermined hardness of the ferrous metal and a very high increase in its fatigue value, increasing thereby its efficient operating life at high engine speeds.

The invention embraces a process whereby a predetermined minimum of hardness is imparted to a high carbon steel member when subjected to a brazing or bonding operation by controlling the cooling rate thereof from said brazing or bonding operation.

The invention is inclusive of a process to increase to a predetermined value the hardness of a steel member having a carbon content ranging from 0.60% to 0.85% when the member is subjected to a brazing or bonding operation by controlling the cooling rate and inhibiting the decarburization thereof.

In the present high speed automotive type of engine it has been necessary to provide an ignition timer or breaker contact lever unit for the ignition system which will be sufficiently responsive to high speeds of operation, without failure, such

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as is demanded in a six-cylinder engine wherein the ignition timer or breaker contact lever has to make and break the ignition circuit 200 times a second when the engine operates at 4,000 R. P. M. The ignition timer or breaker contact structures which have been previously used, have developed operative failures after a comparatively short time of operation. These failures have been due to deformations or by the rupture of the lever arm proper.

It is one of the objects of the invention to overcome the performance failures before enumerated by providing a circuit breaker lever formed from a very thin ferrous sheet material and giving to it great durability with the proper characteristics to withstand for a very long period of time, without deformation or rupture, longitudinal and transverse stresses and impacts, producing thereby a breaker contact assembly having a very long life of efficient functioning without failure or breakage not only at very high speeds but throughout the operating range of the engine.

Another object of the invention is the provision of an impact electrical make and break lever assembly having a very low polar inertia and of a higher mechanical strength than heretofore available.

Another object of the invention is to provide a breaker arm made of a very thin sheet steel heat-treated concurrently with the brazing of a contact point thereto to produce a structure having a very high fatigue strength and a long life of efficient operation for use in very rapid periodic make-and-break electric systems.

Another object of the invention is to improve the structural formation and the physical characteristics of a make-and-break contact lever for engine ignition systems, so that the contact lever operates, without deformation or rupture failure, at very high engine speeds, lasting at least five times as long as the conventional breaker arms used under similar conditions.

Another object of the invention is to provide a process to increase the fatigue strength of a steel member having a carbon content ranging from 0.60% to 0.85% when the member is subjected to a brazing or bonding operation by providing an artificial atmosphere wherein the volume ratio of hydrogen and carbon monoxide is substantially near its equilibrium value for the temperature of the heat application and carbon content of the steel, by controlling its cooling rate from the brazing operation and by the application of an inhibitor to the steel member to prevent the decarburization thereof.

Another object of the invention is to provide an improved method by which a lever arm of thin sheet steel and a tunsten contact point are bonded or brazed and concurrently heat-treated, to secure a predetermined hardness and carbon content of the sheet steel to produce a very high increase in its fatigue strength, increasing thereby the efficient operating life at high engine speeds of the resulting breaker contact structure.

Another object of the invention is the provision of a method and means for producing a lever arm of steel having a carbon content ranging from 0.60% to 0.85% including the step of effecting a coating thereon, which coating acts in a three-fold manner: (1) as an inhibitor which prevents decarburization when the lever arm is placed into a heated zone for bonding its contact member thereto, (2) as means to enhance the bonding of a tungsten contact to the lever arm for producing an effective contact breaker arm assembly, and (3) as an inhibitor preventing oxidation not only due to the atmospheric elements but to ozone produced during its operation as a make-and-break-device in an ignition system.

Among other objects of the invention is the improvement of the breaker arm assembly of the type disclosed in Patent No. 2,054,016 of September 8, 1936, to Louis B. Ehrlich.

Other objects and advantages of this invention relating to the arrangement, operation and function of the related elements of the structure, to various details of construction, to combinations of parts and to economies of manufacture, will be apparent to those skilled in the art upon consideration of the following description and appended claims, reference being had to the accompanying drawings forming a part of this specification wherein like reference characters designate corresponding parts in the several views. Referring to the drawings:

Fig. I is a view illustrating one step in the process of forming the breaker arm from a sheet metal blank;

Fig. II is a view illustrating another step in the formation of the breaker arm assembly;

Fig. III illustrates another step in the formation of the breaker arm assembly;

Fig. IV is a cross-sectional view taken substantially in line 4—4 of Fig. III;

Fig. V is an elevational view illustrating an embodiment of the apparatus to carry out the method of the invention;

Fig. VI is an elevational view of the breaker arm assembly;

Fig. VII is a cross-sectional view taken substantially in line 7—7 of Fig. VI;

Fig. VIII is a cross-sectional view taken along line 8—8 of Fig. VI; and

Fig. IX is an isometric view of the ignition timer or breaker contact structure of the invention.

The invention has been illustrated as embodied in an ignition timer or breaker contact assembly adapted to be used for internal combustion engines but it is to be understood that all the features of the invention are contemplated to be used whenever the same may be found to be applicable.

Referring to the drawings, in Fig. I is illustrated a blank 10 of a substantially triangular configuration, from which the lever arm embodying the invention may be fabricated. The blank 10 may be punched or otherwise produced from

a sheet of thin ferrous material, preferably soft, deep-drawing, cold-rolled steel of a thickness of about .013" to .017". I contemplate that the sheet steel should be fully spheroidized and having a carbon content ranging from 0.60% to 0.85%. To effectively produce a breaker lever assembly embodying the invention, the blank 10 is preferably formed by suitable dies with a longitudinal fold 11 along its medial line, this fold formed into a rib acting as means to increase the strength and rigidity of the structure and is also bent as at 14 for the purpose of reinforcing the end portion, upon which is adapted to be secured an interrupter contact.

In making a lever arm embodying the invention, the width of the blank 10 is preferably decreased from substantially its central portion to its end portion providing the reduced section 15 and at each of the corners the openings 16 and 18 are provided. In addition, the side portions extending from the reduced section 15 are bent along the dotted lines of Fig. II to form substantially parallel spaced walls or flanges 19 and 20. The bending operation will produce the proper alignment of the openings 16 and 18 to thereby accommodate suitable pivotal elements, thus shaping the blank 10 to form the lever arm 22 shown in Fig. III. The lever arm 22 is generally of channel-shaped cross-section having its web or back wall 23 with a central outwardly projecting fold or reinforcing rib 12 preferably extending its full length whereby the end portion 15 is of a T-shaped cross section. The end portion 15 of the breaker arm 22 is formed with a projecting planar end surface or plateau 25, preferably of circular contour and somewhat above the level of the surface of the back wall 23. The plateau 25 is formed to carry in intimate or bonded relation the interrupter contact.

A feature of the invention is the provision of an inhibiting agent to the ferrous material from which the lever arm is fabricated. The inhibiting agent may be applied to the sheet steel by suitable means, preferably by covering the same after a suitable configuration has been given thereto and in carrying out the invention it is contemplated that the inhibiting agent of the invention should be applied as an enclosure such as a coating to the lever arm prior to the bonding thereto of the interrupter contact. The inhibiting agent of the invention preferably takes the form of a coating 26, particularly shown in the cross-section of Fig. IV. The inhibiting enclosure or coating of the invention acts in a three-fold manner: (1) as an inhibitor which prevents decarburization when the lever arm is placed into a heating zone for bonding or brazing the interrupter contact thereto, (2) as means to enhance the bonding or brazing of a tungsten contact to the lever arm for producing an effective contact breaker arm assembly, and (3) as an inhibitor preventing oxidation not only due to the atmospheric elements but to ozone caused by the interrupting of an electric circuit during the normal operation of the arm as a make-and-break device in an ignition system.

I have found that the invention can be best fulfilled when the inhibiting agent takes the form of a very thin nickel coating which, for sake of economical manufacture, can be .0001" or .0002". However, the thickness of this coating may be of a greater dimension, and the application of the inhibiting agent of the invention as a thin coating can be economically carried out

by electroplating the arms to give the nickel covering, as is well known in the art.

After the application of the inhibitor or nickel coating 26, the surface 25 of the breaker arm 22 is adapted to have bonded thereto an interrupter contact 30. This contact may take the form of a disc of tungsten or other suitable material capable of withstanding the mechanical stresses and the deleterious effects caused by its use as an impact current interrupter in an ignition system.

In the manufacture of the breaker arm assembly, the contact 30 is adapted to be placed with a linking wafer 32 of the bonding or uniting member on the end portion 25 of the breaker arm as shown in Fig. III. The uniting member contemplated may take the form of a brazing agent having a flow point between 1600° F. and 2100° F. and preferably formed of electrolytic copper or of a cuprous alloy. However, the linking wafer 32 may be formed of other metals or a combination of metals which effectively wets and bonds the contact 30 to the nickel-plated surface 25 of arm lever 22, provided their flow point is lower than the melting point of the metal of the arm or contact member. As a specific example, it has been found that a disc of .138" to .152" diameter and of a thickness of .006" to .010" of the electrolytic copper or of an approximate 8% nickel copper alloy produces a very effective bonding between the contact element 30 and the breaker arm surface 25.

In the practice of the invention, the interrupter contact 30 and linking wafer 32 are placed and retained in position on the end surface 25 of breaker arm 22 by a suitable supporting standard or block 35. The supporting standard 35 is usually made of carbon or other heat-resisting material not likely to be burned or consumed when placed in the heating zone of a bonding or brazing furnace. In Fig. V the block 35 is shown as holding one breaker arm and contact assembly, but in practice, a plurality are supported by said standard.

In carrying out the invention, the block 35 supporting the breaker arm and contact assembly is preferably inserted into a suitable electric brazing furnace such as the conveyor, pusher or manually operable types adapted to receive an artificial atmosphere. The furnace illustrated in Fig. V is of the pusher type and comprises a receiving table 37, a heating zone 38 with a manually operable or controlled sliding closure 39 and provided with electrical heating units controlled by suitable means 40 to regulate the furnace temperature and adapted to be energized from a source of current by means of switching means 41. The furnace is provided with conduits 43 and 44 for introducing under pressure the artificial atmosphere to realize the invention. After the heating zone 38, the furnace is provided with a cooling zone or heat-treating section 45 which is surrounded by cooling jacket 46 serviced by inlet and outlet pipes 48 and 49 connected to a source of cooling fluid such as cooling water through valves 50 and 50' to regulate the flow and thereby the temperature. The end of the heat-treating section or cooling zone 45 has a discharge table 51 and is provided with a sliding closure 52 manually operated or controlled.

The manual control for the closures 39 and 52 may be interconnected or may take the form of pull handles 53, 53' connected respectively to levers 54, 54' and chain 55, 55' in turn connected to the respective closure 39 or 52, so that, as desired by the operator, manipulation of the pull handle 53 or 53' raises or lowers the closures 39 and 52. Adjacent to the closures 39 and 52, which block the inlet and outlet of the brazing electric furnace, are gas jets 56 and 57 adapted to insure the effective control of the artificial atmosphere as gas will be ignited whenever the closures are open or as it escapes from the closures, forming thereby a curtain blocking the ingress of air into the furnace. However, other suitable means to prevent the ingress of air into the furnace is contemplated.

The brazing furnace to carry out the invention is illustrated as of the pusher type and by placing on the receiving table 37 the blocks 35 and breaker arm contact assembly contained therein one after the other, the same may be pushed into the furnace heating zone 38 where the breaker arm 22 and interrupter contact 30 are bonded together. The temperature of the heating zone of the furnace 38 is preferably kept at a value sufficient to cause the brazing agent 32 to flow or fuse, wetting the lever surface 25, bonding thereto the interrupter contact 30, insuring thereby the proper position and intimate connection of the contact on the breaker arm when the linking metal or brazing alloy solidifies. In practice, the temperature of the furnace may be held at approximately 2050° F. However, this temperature should be correlated with the flow point of the brazing agent or linking alloy used and may range from 1600° F. to 2100° F. The time of heat application contemplated for the bonding and heat-treating operation or the period of time during which the lever arm 22 and its contact assembly is retained in the heating zone under an artificial atmosphere may be correlated and governed by the temperature of the furnace and the carbon content of the material from which the lever arm 22 is formed, as well as by the flow point of the brazing or the linking alloy 32 used and should be of sufficient duration to soak or permeate the arm to impart a uniform temperature thereto.

The artificial atmosphere having a low dew-point contemplated to be introduced above atmospheric pressure into the heating zone and cooling chamber of the brazing furnace, while the arm 22 and contact assembly 30 are being bonded or during the brazing operation, is one wherein the volume ratio of hydrogen and carbon monoxide is substantially near its equilibrium value for the temperature of the heat application and carbon content of the steel from which the lever arm 22 is formed.

As a specific example of the type of artificial atmosphere contemplated, it has been found that the same can be attained by cracking producer gas having an average B. t. u. content of 550. The cracked gas then has the following nominal composition:

Oxygen	None.
Carbon dioxide	None to trace.
Carbon monoxide	20% to 21%.
Hydrogen	39% to 40%.
Methane	1% to 3%.
Nitrogen	38% to 39%.

The above analyses are those produced by the gas cracker when the dew-point ranges between 15° F. and 30° F. This atmosphere is in approximate equilibrium with an approximate .75% carbon steel at approximately 2015° F. This atmosphere may be considered chemically inactive at the temperature specified or one wherein

the potentialities of the nickel inhibitor to prevent decarburization of the steel member are fully realized. Satisfactory results have also been secured when the artificial atmosphere introduced under pressure into the brazing furnace is produced as the result of cracked ammonia gas which, on volume basis, may consist of three volumes of hydrogen and one volume of nitrogen of very low dew-points.

As a specific example of the brazing and heat application of the invention, the same can be fulfilled when the lever arm is fabricated of a fully spheroidized sheet steel having as its main constituents: carbon .70 to 80, manganese .50 to .80, phosphorus, .03 max., sulphur .03 max., silicon .15 to .30 and having a hardness of Rockwell 15T 84 to 86. The arm nickel-plated with a coating ranging from .0001" to .0002", the brazing operation occurring at a furnace temperature ranging from 2000° F. to 2100° F. in an artificial atmosphere of the types before specified and performed by using as bonding agent a copper wafer or a copper nickel brazing alloy, the time of retaining the breaker arm and contact assembly in the heating zone of the furnace being approximately six to eight minutes.

An important feature of the invention is the control of the rate of cooling of the arm from the brazing operation, which control is such that a predetermined hardness is imparted thereto. In this form of the invention, the control of the cooling rate from the brazing operation is accomplished by moving rapidly the block **35** holding the arm and contact assembly from the heating zone into the cooling zone to secure, in effect, a heat-treating operation of the steel from which the arm is made.

The temperature of the cooling zone and the rapidity by means of which the arm with its bonded contact is moved thereinto to secure the rate of cooling to fulfill the invention is subject to many variables and can be best established through the end result as manifested by the hardness of the lever arm after the same is withdrawn from the cooling zone into the discharging table. It is contemplated that the temperature and the control of the rate of cooling of the arm be such that an arm made of steel having a carbon content ranging from 0.60% to 0.85% will test to a minimum hardness of Rockwell B 85 corresponding to Rockwell 45–T 58.

In practice, it has been found that a breaker arm assembly including an arm of a carbon content ranging from 0.60% to 0.85% and having a hardness ranging from Rockwell 45–T 58 to 74 or one possessing a hardness which ranges from 20 to 45 Rockwell "C" fulfills the main objectives of the invention with respect to the proper characteristics of fatigue strength, durability, and efficient operating life without failure at very high speeds. Therefore, the temperature of the cooling zone and the rapidity of moving the bonded arm thereinto should be so controlled to secure the hardness hereinbefore specified, and particularly with the Rockwell hardness ranging from 20 to 45 "C," the same can be secured through a proper control by using a very low temperature coolant and imparting to the cooling chamber a low temperature.

In determining the rate of cooling required, it has been found advisable to establish the same by trial runs, testing the hardness of the end product such as a brazed breaker arm assembly and noting the temperature of the incoming coolant, position of valves **50** and **50'** and the temperature of the jacket **46**. As a specific example, satisfactory results have been secured when the temperature of the jacket is retained at approximately 75° to 90° for a comparatively short cooling zone furnace. However, the desired hardness has been secured when the temperature of the jacket is kept at approximately 70° F. using cooling water having a temperature not above 60° F. for a relatively long cooling zone furnace.

It is contemplated that the amount of the bonding agent **32** should not only produce an intimate bond between the breaker arm surface **25** and the contact **30**, but will flow bonding the contiguous walls of the reinforcing rim **12**, as is particularly shown in Figs. VII and VIII, thereby serving a dual purpose.

A breaker arm assembly produced from steel with the carbon content specified covered with the inhibiting agent of the invention with a contact bonded by brazing the same under the conditions hereinbefore outlined and wherein the rate of cooling has been controlled, as hereinbefore specified, provides a resulting structure which has the desired hardness and a very high fatigue strength. The breaker contact lever, produced in accordance with the invention, is characterized as being rust-proof, non-oxidizable by ozone, having partial lamellar pearlitic structure with no decarburized areas such as manifested by free ferrite, and of sufficient ductility so that the surface at the pivotal end of the arm adjacent to the openings **16** and **18** may bend to a wide angle such as 90° without fracture.

The means contemplated for the breaker arm to form the same as an impact contact for an electrical make-and-break device of an ignition system are illustrated in Fig. IX and comprises a spacing and reinforcing metallic bushing **60** located in the aligned openings **16** and **18** of the breaker arm lever **22**. The bushing **60** has reduced ends forming shoulders adapted to be engaged by the inner surface of the side walls **19** and **20** and the end portions projecting through the aligned openings are swedged over the side walls, as at **61**, in order to retain them in proper spaced position. The bushing **60** snugly retains an insulating bushing **62** which serves as a pivotal insulating bearing for the arm assembly about a pivotal post, not shown.

Between the parallel walls **19** and **20** of the breaker arm lever **22** is fixedly secured to the web section **23** an L-shaped rubbing block **65** by means of suitable rivets **67** and **68** which also serve to secure an electric current conducting strip **70**. The conducting strip **70** forms an efficient connection for reducing the electrical resistance for the flow of current to the contact **30** through the breaker arm structure. The rubbing block is preferably of an L-shaped formation made of a non-conducting material, preferably a fabric permeated or stiffened with a condensation product. The rivets **67** and **68** are spun against the inner face of the rubbing block as at **72** and urge, by means of the rubbing block, the conducting strip **70** into very effective contacting engagement with the nickel-plated surface of the web section **23** of the breaker arm. The rivets **67** and **68** provide very effective means to retain the rubbing block **65** and strip **70** in proper fixed position and thereby decreases, to a minimum, the number of parts forming the breaker arm assembly of the invention.

It can be seen from the foregoing that the in-

vention herein disclosed is a material improvement over the conventional brazing operation and that, by the control of the rate of cooling from said operation to secure predetermined hardness, an effective and very inexpensive method of heat-treating any steel member is provided when the steel member is subjected to a brazing operation. The specific embodiment of the invention disclosed produces a breaker arm having physical characteristics and a molecular structure which gives a very high fatigue strength and provides a long life of efficient operation for the breaker arm as an impact contact make-and-break device for an electric circuit such as that of an ignition system for engines. The contact arm produced by the invention has a lower polar inertia and a higher mechanical strength as well as a higher fatigue strength than heretofore available, so that deformation and rupture are practically avoided under normal conditions of use.

In describing the invention, in the interest of clarity, the same has been confined to brazing of the contact point to a preformed ferrous member of sheet steel. However, it is to be understood that the invention and the procedures disclosed herein are well adapted for brazing ferrous metals of the carbon content mentioned to secure the physical and strength characteristics hereinbefore outlined.

It is to be understood that the above detailed description of the present invention is intended to disclose an embodiment thereof to those skilled in the art, but that the invention is not to be construed as limited in its application to the details of construction and arrangement of parts illustrated in the accompanying drawings, since the invention is capable of being practiced and carried out in various ways without departing from the spirit of the invention. The language used in the specification relating to the operation and function of the elements of the invention is employed for purposes of description and not of limitation, and it is not intended to limit the scope of the following claims beyond the requirements of the prior art.

What is claimed:

1. An ignition breaker arm structure comprising a high carbon steel arm, an overall sealing cover solely of nickel directly enclosing said arm, a tungsten interrupter contact brazed to said nickel sealing cover, the brazing of said contact to said nickel sealing cover secured by a cuprous brazing alloy having a melting point below that of said nickel cover ranging between 1600° F. to 2100° F. fused therebetween, the said arm having lamellar pearlite characteristic and a carbon content ranging from 0.65% to 0.80% with a hardness ranging from 30 to 45 Rockwell in the "C" scale having sufficient ductility to permit bending portions of the arm to wide angles without fracture.

2. An ignition breaker arm structure comprising a high carbon steel arm plated by an overall sealing covering consisting solely of nickel and with the interrupter contact brazed to said nickel covering, the brazing of said contact to said nickel sealing covering formed by fusing therebetween a copper nickel allow having a flow point lower than said covering about 2000° F. to 2100° F., said arm formed of fully spheroidized sheet steel and being characterized after the brazing of the contact by having substantially no decarburized areas and a carbon content of approximately 0.75% with a Rockwell 45–T hardness ranging from 58 to 74 with sufficient ductility to allow bending a portion of the arm structure to a wide angle over 90° without fracture.

3. In electrical periodic circuit interrupting structures, the combination comprising a high carbon steel member, a coating consisting solely of plated nickel sealing completely said steel member, a contact member, means uniting said contact member to the nickel coating including a copper nickel brazing alloy of a lower melting point than said nickel coating fused between contact member and coating, said brazing alloy having a flow point between 2000° F. and 2100° F., the said steel member having a carbon cantent ranging from 0.70% to 0.80% with a Rockwell hardness of at least 85 in the "B" scale having sufficient ductility to allow bending portions of the structure to substantially right angles without fracture and the nickel coating on said steel member inhibiting decarburization during the brazing operation while increasing the strength of the bond between the contact and member and preventing oxidation during its normal operation as a periodic circuit interrupter.

4. An electric impact current conducting structure, comprising a high carbon steel member having a contact supporting surface, a thin plated coating consisting solely of nickel forming an inhibiting sealing enclosure for said steel member and its contact supporting surface, a tungsten contact member brazed to said contact supporting surface by a copper brazing alloy having a flow point below the melting point of said nickel enclosure, the brazing alloy having a flow point ranging from 2000° F. to 2100° F. interposed and fused uniting said contact to the nickel coating on said contact supporting surface, and said steel member characterized after the contact has been brazed to the nickel coating on said contact supporting surface by having lamellar pearlite characteristics with substantially no decarburized areas and with a carbon content ranging from 0.60% to 0.80% with a Rockwell hardness ranging from 58 to 74 Rockwell 45–T in which sufficient ductility is retained for bending parts thereof at a wide angles without fracture.

5. The method of producing a make and break contact arm assembly which comprises forming the arm from sheet steel fully spheroidized having a carbon content ranging from 0.60% to 0.80%, plating directly on said arm by electrodeposition a sealing cover consisting solely of nickel, bonding a make and break contact to said plated arm by brazing in an artificial atmosphere which prevents decarburization a tungsten point to the nickel sealing cover by fusing therebetween a brazing alloy consisting of copper and 8% of nickel in a heating zone at a temperature below the melting point of said nickel cover ranging from 2000° F. to 2100° F., and controlling the cooling rate of the plated arm with its brazed contact while being subjected to said artificial atmosphere after the brazing operation in the heating zone to impart to the arm a hardness ranging from 30 to 45 Rockwell "C" scale and sufficient ductility so that portions of the arm will bend to at least a 90° angle without fracture and producing a very strong bond between the tungsten point and the steel arm with a material increase in the fatigue strength of the assembly.

6. The method of increasing the fatigue strength of a high carbon steel member for a make and break contact assembly having a carbon content of 0.60% to 0.80% when the member is subjected to a brazing operation for bond-

ing a contact to the member which comprises completely covering said steel member by electro-depositing thereon as an inhibiting enclosure a thin coating consisting solely of nickel prior to the application of heat to obtain the brazing operation, brazing the contact to the member in a heating zone having a temperature lower than the melting temperature of said coating, the heating zone having a maximum temperature of 2100° F. and an artificial atmosphere wherein the volume ratio of hydrogen and carbon monoxide is substantially near its equilibrium value for the temperature of the heat application and the carbon content of the steel member, and controlling the rate of cooling of the member in said artificial atmosphere after the brazing operation for effecting a substantial increase in the Rockwell hardness of the steel member and retaining sufficient ductility so that portions of the steel member will bend at 90° without fracture.

7. The method of producing a breaker arm contact assembly which comprises of forming the arm of sheet steel having a carbon content ranging from 0.70% to 0.80%, electroplating directly upon said arm a thin coating of pure nickel forming a sealing enclosure, bonding a contact member to the nickel coating in a heating zone having a temperature below the melting point of said nickel coating by fusing a cuprous alloy at a temperature that does not exceed 2100° F. in an artificial atmosphere which prevents decarburization, and controlling the rate of cooling of the arm with its brazed contact after the brazing operation in an atmosphere which prevents decarburization to impart simultaneously added strength to the bond between the contact member and the arm and produce a hardness for the steel member ranging from 30 to 45 Rockwell "C" scale in which sufficient ductility is retained so that portions of the arm will bend to a 90° angle without fracture producing a breaker arm assembly having an average fatigue life of at least five times that of an assembly made of low carbon steel operating under the same conditions.

8. The method of increasing the fatigue strength of a high carbon steel member for a make and break contact assembly having a carbon content of about 0.75% when the member is subjected to a copper brazing operation for bonding a tungsten contact to the member which comprises electroplating the member with a thin coating consisting solely of pure nickel prior to the application of heat to obtain the copper brazing operation, the copper brazing operation obtained by fusing a copper alloy between the tungsten contact and the nickel coating at a temperature below the flow point of the nickel coating not exceeding 2100° F. in an artificial atmosphere wherein the volume ratio of hydrogen and carbon monoxide is substantially near its equilibrium value at 2100° F. for a 0.75% carbon steel member, and controlling the rate of cooling of the member in said artificial atmosphere for imparting a hardness ranging from 30 to 45 Rockwell "C" for the steel member and retaining sufficient ductility so that portions of the steel member will bend at substantially right angles without fracture.

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