PATENT SPECIFICATION

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PROVISIONAL SPECIFICATION

Substitute for Metal Castings

I, GEORGE CONSTANTINESCO, British subject, of Oxen House, Torver, Coniston, Lancashire, do hereby declare the nature of this invention to be as follows:—

The object of this invention is to provide a method and means to produce a substitute material to replace metal castings.

The invention is particularly applicable to replace metal castings for frames, supports, bed-plates, pulleys, flywheels, crank cases, gear boxes, engines, marine fittings, pumps, bearings, turbines, machine tools, pipes, armour protection, bomb-proof shelters, and generally any structures where strength under relative light weight and low cost are important considerations, but where volume occupied by the material is of secondary importance.

According to my present invention this substitute material, which hereinafter I will call shortly Feron, is made of a three-dimensional and uniformly distributed mattress of wire composed of short coils of helical elements which are dropped into all parts of the mould. The mould is finally filled with a suitable cementing mass like quick-setting cement, or cement mortar, plaster of paris, clay, resins, or any other compounds that will set hard under the influence of water or heat.

The mattress is obtained by dropping one by one, or feeding a continuous stream into the mould, of separate short helical coil elements made of either ordinary round section wire or preferably of twisted square, rectangular, or cross-shaped section, so as to increase adhesion.

According to one example, the coil elements have a pitch of two coil diameters, are cut to lengths of about one convolution, and have a developed length of about one hundred diameters of the wire.

For special purposes these proportions may be varied so as to obtain any desired proportion of steel in the final product.

If a large number of such elements are fed separately into any mould cavity of dimensions larger than the overall dimensions of the elements, a three-dimensional interlocked structure is formed in the cavity.

The coil elements are made and fed into the mould so that at any place half of their number are right-handed and the other half left-handed helices.

These elements interlock automatically into an uniform distribution of fibres in all directions, resembling a mattress, with sufficient interspaces to admit the cementing mass. To obtain this result, the elements are dropped independently, either by simple gravity, or fed into the mould in a continuous stream of separate elements projected with the help of a stream of air or water.

After the mould has been charged with elements as aforesaid, the cementing compound is poured into the mould so as to imbed the whole of the mattress formed in the mould.

In order to expel the air and assist the uniform distribution of the cementing compound, the mould is kept under continuous vibration until completely filled.

The final product, after setting and hardening, is a new material that has a three-dimensional and uniformly increased resistance, not only to compression, but also to traction, shearing and bending in every direction.

The size of the coil elements and the nature of the cementing compound depend on the thickness of the casting required. For thin castings, the section of the wire may be only a small fraction of a square millimetre imbedded in mortar of neat cement, or cement mixed with fine sand. For thick castings, the elements may be made of steel sections up to several square centimetres imbedded in concrete made of cement mortar and gravel.

If desired, the elements may be made of different sizes mixed in appropriate proportions.

Feron made according to this invention is very tough, possesses tenacity and plasticity and can take considerable tension, shearing and bending stresses in every direction. This is due to the uniform distribution of metal fibres that form a three-dimensional interlocked structure in every part of the Feron mass.

Experiment shows that fissures cannot be propagated in Feron and internal cracks cannot take place. Feron material can be moulded in any curved and intricate shapes, in which reinforcement will be impossible by other means. For example, bearing casings can be made completely in one piece with all intricate inside cavities to locate the necessary metallic bearing surfaces, ring cavities, oil reserve, felt washers or any other desired accessories.

Experiment shows that the peculiar mattress of adhesive filaments curved in three dimensions, imparts to the whole mass of Feron new properties of tenacity and plasticity in every direction which are absent in the cementing compound alone.

For example, hammers can be made of Feron and a very considerable number of blows can be delivered without disintegration taking place.

The same applies to Feron bearing castings, engine castings, crankcases, machine tool frames, armour plates, stoves, gas-producers and like structures subjected to vibrations, shocks and non-uniform heating.

For general purposes, the proportion of steel in Feron finished products made by this method is about one-tenth of the weight. Therefore an economy of iron of some 90% can be achieved in replacing cast iron products with Feron products of the same weight.

In all cases where ordinary metal castings have to be made much thicker than necessary, for the sake of rigidity and to resist corrosion, such castings could be replaced with Feron and a considerable reduction in weight results. The specific gravity of Feron is between 2.3 and 2.5 and is therefore a little less than aluminium and about one third of cast iron.

Feron has a fairly high and uniform magnetic permeability and therefore is suitable for use in the construction of monolith frames for electric generators and motors, thus reducing to the minimum the quantity of iron required for the poles of stators or rotors. Moreover, the peculiar structure of the mattress in Feron castings prevents the building up of parasitic electric currents in the mass and therefore no heat can be generated from alternating magnetic fields. By increasing the iron content of the elements, the permeability can be increased very substantially and Feron castings could be used directly as magnetic circuits in the construction of alternators, dynamos and transformers.

The capacity to resist shocks makes Feron suitable for wheels of any kind, as pulleys, drums and for vehicles like motor cars, lorries, agricultural tractors, road rollers and railways.

In ship construction the non-corrosive properties of Feron makes it suitable to replace most of the heavy and light castings on board. Emergency and permanent propellers can be made entirely of Feron.

For the same weight, Feron castings can have sections three times larger than cast iron. Greater rigidity is thus obtained and simpler forms can be adopted, thus eliminating complicated stiffenings required in metal castings. Moreover, Feron objects can be cast in place ready in their final position and thus the transport of heavy castings can be avoided.

Feron has a coefficient of expansion with temperature of the same order as steel and it is therefore suitable to be incorporated with iron or steel parts. Additional reinforcements can easily be provided in the form of tensions bars in all parts of the mould where high tension stresses are expected. This permits the casting of, for example, flywheels, crank cases for engines, and cylinder blocks for steam or internal combustion engines, or machine tools, in combination with bolts and metallic rings and linings limited only to the parts where absolutely necessary.

The most suitable material for the coil elements is steel, and for the cementing material quick-setting aluminous cement mortar with sand, or even neat for small castings.

For large castings the coil elements may be made proportionally larger and ordinary concrete made of cement mortar and small gravel may be used.

The invention is not limited to these materials. The elements may be made of any other metals, and the cementing materials may be magnesia or plaster of paris or any other materials like silica, resin or clay compounds that can be set by the influence of heat.

Another property of Feron is its capacity to resist penetration by projectiles. It is thus indicated as suitable for replacing steel armour plating.

The specific gravity is less than one third when compared with steel. Therefore Feron armour can be made at least three times thicker for the same weight and can be cast in position as a monolith structure, thus avoiding weak joints.

The greater thickness offered to the penetration of projectiles combined with the great rigidity and inertia of the volume opposing the penetration would localise the damage to the outside of the armour.

It is known that fibrous masses like saw-dust, offer great resistance to the passage of projectiles. The three-dimensional fibrous texture of the mattress imbedded in Feron has a similar effect.

The relatively low heat conductivity of Feron combined with its tenacity and resistance to penetration makes the material suitable for the economical and rapid construction of complete monolith army tanks, mobile forts, pill-boxes, air raid shelters, deck armour, gun cupolas, gun mountings and the like, with a corresponding large economy of steel.

Dated the 11th day of February, 1943.

G. CONSTANTINESCO.

COMPLETE SPECIFICATION

Substitute for Metal Castings

I, George Constantinesco, British subject, of Oxen House, Torver, Coniston, Lancashire, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

The object of this invention is to provide a method and means to produce a substitute material to replace metal castings.

The invention is particularly applicable to replace metal castings for frames, supports, bed-plates, pulleys, flywheels, crank cases, gear boxes, engines, marine fittings, pumps, bearings, turbines, machine tools, pipes, armour protection, bomb-proof shelters, and generally any structures where strength under relative light weight and low cost are important considerations, but where volume occupied by the material is of secondary importance.

According to my present invention this substitute material, which hereinafter I will call shortly Feron, is made of a three-dimensional and uniformly distributed mattress of wire composed of short coils of helical elements which are dropped into all the parts of the mould. The mould is finally filled with a suitable cementing mass like quick-setting cement, or cement mortar, plaster of paris, clay, resins, or any other compounds that will set hard.

The mattress is obained by dropping one by one, or feeding a continuous stream into the mould, of separate short helical coil elements made of either ordinary round section wire or preferably of twisted square, rectangular, or cross-shaped section, so as to increase adhesion.

According to one example, the coil elements have a pitch of two coil diameters, are cut to lengths of about one convolution, and have a developed length of about one hundred diameters of No. 20 to No. 33 wire gauge.

If the wire is of very hard material the length of the elements can be increased to about three hundred times the wire diameter with a pitch of two to six coil diameters for one convolution.

For special purposes these proportions may be varied so as to obtain any desired proportion of metal in the final product.

If a large number of such elements are fed separately into any mould cavity of dimensions larger than the overall dimensions of the elements, a three-dimensional interlocked structure is formed in the cavity.

The coil elements are made and fed into the mould so that at any place half of their number are right-handed and the other half left-handed helices.

These elements interlock automatically into an uniform distribution of fibres in all directions, resembling a mattress, with sufficient interspaces to admit the cementing mass. To obtain this result, the elements are dropped independently, either by simple gravity, or fed into the mould in a continuous stream of separate elements projected with the help of a stream of air or water.

After the mould has been charged with elements as aforesaid, the cementing compound is poured into the mould so as to imbed the whole of the mattress formed in the mould.

In order to expel the air and assist the uniform distribution of the cementing compound, the mould is kept under continuous vibration until completely filled.

The final product, after setting and hardening, is a new material that has a three-dimensional and uniformly increased resistance, not only to compression, but also to traction, shearing and bending in every direction.

The elements being dropped at random but in a regular sequence of right and left helices, the resultant structure is a system of interlocked fibres distributed in all directions showing a regular and isotropic three-dimensional structure. I have found that such a system of fibres imbedded in a cementing compound, if subjected to a field of tension in one given direction, resists as an equivalent virtual system of continuous parallel straight fibres in that direction.

For example, in a unit volume of Feron containing proportion p of steel wire distributed as aforesaid, if subjected to a tension in one direction, the equivalent virtual system of parallel straight and continous fibres of the same resistance in that direction will have the proportion of kp of steel wire per unit of volume.

The factor k is smaller than unity and for a three-dimensional isotropic distribution, k is the same in any chosen direction and has the value of about 1/3.

A non - isotropic three - dimensional structure is obtained with elements that are longer relatively to the cross section of the object, the length being several times the diameter of the helix.

Such elements dropped on a flat surface produce a nearly two - dimensional isotropic structure, the factor k approaching 1/2, while in the direction perpendicular to the surface the value of k diminishes.

As the elements pile up on the flat surface the two - dimensional isotropy is gradually changing to three dimensional. Consequently plates of Feron will show a higher resistance to bending if the tension side is on the side where the elements have been dropped first into the mould, because the factor k is higher near the flat surface. Such a distribution is of advantage in slabs subjected to bending on account of the high value of the factor k in the direction of the principal tensions.

The size of the coil elements and the nature of the cementing compound depend on the thickness of the casting required. For thin castings, the section of the wire may be only a small fraction of a square millimetre imbedded in mortar of neat cement, or cement mixed with fine sand. For very thick castings, the elements may be made of steel sections up to several square centimetres imbedded in concrete made of cement mortar and gravel.

If desired, the elements may be made of different sizes mixed in appropriate proportions.

Feron made according to this invention is very tough, possesses tenacity and plasticity, and can take considerable tension, shearing and bending stresses in every direction. This is due to the uniform distribution of fibres that form a three-dimensional interlocked structure in every part of the Feron mass. Experiment shows that fissures cannot be propagated in Feron and internal cracks cannot take place. Feron material can be moulded in any curved and intricate shapes, in which reinforcement would be impossible by other means. For example, bearing casings can be made completely in one piece with all intricate inside cavities to locate the necessary metallic bearing surfaces, ring cavities, oil reserve, felt washers or any other desired accessories.

Experiment shows that the peculiar mattress of adhesive filaments curved in there dimensions, imparts to the whole mass of Feron new properties of tenacity and plasticity in every direction which are absent in the cementing compound alone.

For example, hammers can be made of Feron and a very considerable number of blows can be delivered without disintegration taking place.

The same applies to Feron bearing castings, engine castings, crank cases, machine tool frames, armour plate, stoves, gas-producers and like structures subjected to vibrations, shocks and non-uniform heating.

For general purposes, the proportion of steel in Feron finished products made by this method is about one-tenth of the weight. Therefore an economy of iron of some 90% can be achieved in replacing cast iron products with Feron products of the same weight.

In all cases where ordinary metal castings have to be made much thicker than necessary, for the sake of rigidity and to resist corrosion, such castings could be replaced with Feron and a considerable reduction in weight results. The specific gravity of Feron is between 2.30 and 2.50, and is therefore a little less than aluminium, and about one third of cast iron.

Feron has a fairly high and uniform magnetic permeability and therefore is suitable for use in the construction of monolith frames for electric generators and motors, thus reducing to the minimum the quantity of iron required for the poles of stators or rotors. Moreover, the peculiar structure of the mattress in Feron castings prevents the building up of parasitic electric currents in the mass and therefore no heat can be generated from alternating magnetic fields. By increasing the iron content of the elements, the permeability can be increased very substantially and Feron castings could be used directly as magnetic circuits in the construction of alternators, dynamos and transformers. To further increase the magnetic permeability, the cementing compound can be made of a mixture of 2 parts of iron filings with one part of cement.

The capacity to resist shocks makes Feron suitable for wheels of any kind, as pulleys, drums, for vehicles like motor cars, lorries, agricultural tractors, road rollers and railways.

In ship construction the non-corrosive properties of Feron makes it suitable to replace most of the heavy and light castings on board. Emergency and permanent propellers can be made entirely of Feron.

For the same weight, Feron castings can have sections three times larger than cast iron. Greater rigidity is thus obtained and simpler forms can be adopted, thus eliminating complicated stiffenings required in metal castings. Moreover, Feron objects can be cast in place ready in their final position and thus the transport of heavy castings can be avoided.

Feron has a coefficient of expansion with temperature of the same order as steel and it is therefore suitable to be incorporated with iron or steel parts. Additional reinforcements can easily be provided in the form of tension bars in all parts of the mould where high tension stresses are expected. This permits the casting of, for example, flywheels, crank cases for engines, and cylinder blocks for steam or internal combustion engines, or machine tools, in combination with bolts and metallic rings and linings limited only to the parts where absolutely necessary.

The rupture resistance to bending of Feron slabs varies between 150 to 450 kilograms per square centimetre, depending on the tensile strength of the elements and the quality of the cementing compound. This permits the construction of girders, slabs, planks and the like, showing a load capacity comparable with that of cast iron or with standard laminated mild steel sections of the same weight.

The steel wires that form the elements in Feron castings have a resistance to rupture from 3 to 12 times higher than ordinary iron or mild steel in laminated sections. Therefore in spite of the isotropic distribution of the metal fibres in Feron products, the ultimate resistance to tension, shearing, and compression in every direction is high.

Feron sections show a higher resistance to rupture than ordinary reinforced concrete structures. Consequently, lighter constructions can be obtained for floorings, roofings, columns, and other building components.

Feron columns subjected to heavy pressures show outside signs of heavy stresses long before the interior section is crushed, and give warning in time. This indicates Feron as a suitable material for pit props in mining work.

The most suitable material for the coil elements is steel, and for the cementing material quick-setting aluminous cement mortar with sand, or even neat for small castings.

The invention is not limited to these materials. The elements may be made of any other metals, and the cementing materials may be magnesia or plaster of paris or any other materials like silica, resin, or clay compounds that can be set by the influence of heat.

Another property of Feron is its capacity to resist penetration by projectiles. It is thus indicated as suitable for replacing steel armour plating.

The specific gravity is less than one third when compared with steel. Therefore Feron armour can be made at least three times thicker for the same weight and can be cast in position as a monolith structure, thus avoiding weak joints.

The greater thickness offered to the penetration of projectiles, combined with the great rigidity and inertia of the volume opposing the penetration would localize the damage to the outside of the armour.

It is known that fibrous masses like saw dust, offer great resistance to the passage of projectiles. The three-dimensional fibrous texture of the mattress imbedded in Feron has a similar effect.

The relatively low heat conductivity of Feron combined with its tenacity and resistance to penetration makes the material suitable for the economical and rapid construction of complete monolith army tanks, mobile forts, pill-boxes, air raid shelters, deck armour, gun cupolas, gun mountings and the like, with a corresponding large economy of steel.

I am aware that ready-made bundles of metal shavings, iron fibre (paille de fer), metal, wool, iron straw, metal hair and the like have been proposed as reinforcements in cementing compounds. The irregularly-shaped fibres of which these textures are made have not the correct curvature, nor the uniform distribution which are essential conditions for imparting to the final product an increased uniform capacity for tension resistance in all directions comparable with metal castings. Such ready-made bundles or packets of fibres cannot be inserted into intricate moulds without leaving surfaces of discontinuity where the fibres of adjacent bundles cannot be interlocked. Across such surfaces of discontinuity the tension resistance of the final product remains practically the same as if the cementing compound had not been reinforced at all.

I do not claim that my invention covers any such products made by imbedding ready-made bundles of irregularly-shaped wires into cementing compounds.

It has also been proposed to reinforce

cementing compounds by imbedding parallel or adjacent helical wire springs having many convolutions. Such structures do not provide an uniform three-dimensional distribution of fibres capable of resisting tension in all directions. Any field of tension parallel or across the axis of the springs will rupture first the cementing compound and open out the springs afterwards.

I do not claim that my invention covers any products made by imbedding such helical springs in a cementing compound.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. A substitute for metal castings made by directing into a mould a stream of separate helical wire elements forming automatically in the mould a three-dimensional uniformly distributed interlocked structure, the mould being subsequently filled with a cementing compound.

2. A substitute for metal castings as claimed in Claim 1, the wire elements being fed into the mould in a regular sequence of right-handed and left-handed helices.

3. A substitute material for metal castings made of helical right- and left-handed elements dropped uniformly at random into a mould until a regularly built three-dimensional uniformly distributed interlocked structure is obtained, the mould being subsequently filled with a cementing compound while it is maintained in vibration.

4. A substitute material for metal castings as claimed in any preceding claim in which the helical elements are made of wires of the order of one tenth to several millimetres diameter, a length of 100 to 300 wire diameters, pitch of 2 to 6 coil diameters, and about one convolution.

5. A substitute material as claimed in any preceding claim having a high magnetic permeability and in which the helical elements are imbedded in a mortar made of iron filings and a cementing compound.

Dated the 12th day of January, 1944.
G. CONSTANTINESCO.

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