PATENT SPECIFICATION

585,047

Application Date: July 8, 1944. No. 13070/44.

[Patent of Addition to No. 568,066: dated Feb. 12, 1943.]

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Complete Specification Accepted: Jan. 29, 1947.

PROVISIONAL SPECIFICATION

Improvements in 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 an improved means by which a substantial reduction of wire can be effected in the manufacture of Feron material as described in my Patent Application No. 2340, of 12th February, 1943, Serial No. 568,066, the ultimate strength of Feron remaining the same.

The invention consists in making the Feron helical elements out of wire which has been corrugated in the form of a sinusoidal curve of a large number of small waves so that the curvature changes rapidly from plus to minus many times in succession along the axis of the wire.

A simple way to obtain this result is to pass the wire through a pair of suitably shaped gears compressing and permanently moulding the wire between their teeth to the desired wave-like curve. This corrugated wire is then coiled in helical elements and cut to the necessary lengths to form the Feron elements as described in the above specification.

The proportions for the corrugations are important. If $\pm A$ is the amplitude of the wave-like line, T the length of the wave, D the diameter of the wire, and $A = cD$ and $T = mD$, then suitable values of c are between 0.5 and unity and of m, between 5 and 10.

The correct values for these coefficients depend on the ultimate tensile strength of the wire and also on the crushing strength of the cementing compound and are best determined by experiment.

Feron elements made of such corrugated wires have a much higher adhesion in the cementing compound than wires of other kinds either round, square, flat, plain or twisted. Elements of such corrugated wire imbedded in Feron when subjected to a field of tension produce, at all the points of large curvature, high local pressures at right-angles to the axis of the wire. This considerably increases the grip, with the result that a much shorter length of the helical elements is required in order to secure the benefit of the high tensile strength of the wire for the major part of the element.

It can be shown by mathematical analysis and by experiment that the "idle" lengths at the ends of the elements (the portions where the actual tension of the wire diminishes rapidly towards nil at the extremities) are reduced to nearly one tenth of the idle lengths necessary for non-corrugated wires.

This advantage becomes of paramount importance when using wires of very high tensile strength. For example, elements made of wires showing a tensile strength of the order of 270 kilogrammes/square millimetre, if made from corrugated wire as above, have idle ends totalling only about 50 diameters of the wire. If the same wire is not corrugated the idle ends total 500 diameters.

Therefore if the elements are made, for practical reasons, with a total length of only 300 diameters, such high tensile wire could never be stressed to its full capacity if made of normal wire. However, if the elements are made of the same wire but corrugated as specified above, a length of at least 250 diameters out of the total of 300 diameters could be stressed to its full tensile capacity without pulling out the idle ends.

It follows that very high tensile wire elements can be used for Feron material without the necessity of wasting a considerable length of wire in the idle ends.

Corrugated wire elements imbedded in Feron have another important function when high tensile wire is used. Non corrugated wire made of very high tensile steel has negligible elongation and is apt to break "in succession" when the Feron material is overloaded in tension. Thus in slabs subjected to bending, the external fibres in the tension regions are broken first and the other fibres towards the neutral axis of the slab break in quick succession afterwards.

Corrugated high tensile fibres provide a virtual elongation due to the minute elastic and plastic lateral compressions in the cementing compound caused by the alternating curvatures of the corrugated wire trying to stretch out in a field of tension. Thus a virtual elongation is possible in corrugated wire elements and is of an elastic nature, independent of the lack of plastic elongation of the wire.

In another form of the invention, instead of providing corrugations on the whole length of the helical elements, I provide corrugations only on the idle portions at the extremities of each element. The corrugated lengths in this case are determined by the condition that the force necessary to pull out the wire from the corrugated ends, when imbedded in mortar aggregate, should be equal to the force necessary to break the wire in tension on the non-corrugated middle ortion. In this case the adhesion on the non-corrugated middle portion of the element will be overcome in an intense field of tension and will not play any important part when the tension in the wire reaches high values. The idle corrugated ends will act then as progressive anchorages for the middle portion. Such end-corrugations may be made with variable amplitude, greater amplitudes at the extremities gradually diminishing towards the non-corrugated middle portions of the helical element.

An interesting feature of this invention is that the capacity of wires to resist tension is very little affected by corrugations as specified above, provided a large number of elements are present in every direction of the Feron material. This is due to the fact that there is no freedom for an excessive deformation of the wave-shaped curve of the axis of the wire. Under a high longitudinal tension the tendency of the curve is to flatten out, but this cannot take place except if the cementing compound is crushed in a direction perpendicular to the axial direction of the wire. But such crushing cannot take place easily, there being no room for lateral expansion. What takes place is a plastic redistribution of the internal structure and stresses in the cementing compound. The final result is that after the whole material has been subjected to a substantial field of tension, when the external forces are removed, the internal structure is left in a state in which the corrugated wire elements are left under permanent tension, and the cementing compound under a permanent field of compression.

This is a great advantage as it permits the best use to be made of the respective properties of wires to take tensions and the cementing compound only compressions.

To produce a slab of Feron, when the initial internal distribution of stresses is tension in the corrugated wire elements and compression in the mortar aggregate, it will be sufficient to subject the slab to a preliminary loading in excess of the normal load contemplated. The excess must not be beyond the safe load which the slab can support without disaggregations of the mortar due to excessive internal deformations. Any lesser loading will only relieve the initial compressions in the mortar aggregate and increase the initial tensions in the corrugated wire elements.

The adhesion due to corrugated elements, made as above, is of an entirely different kind than the adhesion produced by the sticking of cement mortar to ordinary wires. The difference will be made apparent at once if one will consider that such a corrugated wire will not pull out of its lodging in the mortar even if the coefficient of friction may be nil.

Due to the relative rigidity of the corrugations made with proportions as specified above, the adhesion comes chiefly from the necessity to shear a large perimeter of mortar in order to pull out the corrugated wire. This perimeter is proportionally much larger than for square or rectangular twisted wires which act in a similar way.

As the ultimate tensile strength of Feron is directly proportional to the tensile stress of the wire, this invention gives the possibility to increase the tensile strength of Feron to the maximum possible with a minimum weight of steel wire and so at the same time allows ample space between the wire elements for the mortar aggregate.

Dated the 6th day of July, 1944.
G. CONSTANTINESCO.

COMPLETE SPECIFICATION

Improvements in 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 an improved means by which a substantial reduction of wire can be effected in the manufacture of Feron material as described in my Patent Application No. 2340 of 12th February 1943 (Serial No. 568,066), the ultimate strength of Feron remaining the same.

The invention consists in making the Feron helical elements out of wire which has been corrugated in the form of a sinusoidal curve of a large number of small waves so that the curvature changes rapidly from plus to minus many times in succession along the axis of the wire.

A simple way to obtain this result is to pass the wire through a pair of suitably shaped gears compressing and permanently moulding the wire between their teeth to the desired wave-like curve. This corrugated wire is then coiled in helical elements and cut to the necessary lengths to form the Feron elements as described in the above specification.

The proportions for the corrugations are important. If $\pm A$ is the amplitude of the wave-like line, T the length of the wave, and D the diameter of the wire, and $A = cD$ and $T = mD$, then suitable values of c are between 0.5 and unity and of m between 5 and 10.

The correct values for these coefficients depend on the ultimate tensile strength of the wire and also on the crushing strength of the cementing compound and are best determined by experiment.

Feron elements made of such corrugated wires have a much higher adhesion in the cementing compound than wires of other kinds, either round, square, flat, plain or twisted. Elements of such corrugated wire imbedded in Feron when subjected to a field of tension produce, at all points of large curvature, high local pressures at right-angles to the axis of the wire. This considerably increases the grip, with the result that a much shorter length of the helical elements is required in order to secure the benefit of the high tensile strength of the wire for the major part of the element.

It can be shown by mathematical analysis and by experiment that the "idle" lengths at the ends of the elements (the portions where the actual tension of the wire diminishes rapidly towards nil at the extremities) are reduced to nearly one tenth of the idle lengths necessary for non-corrugated wires.

This advantage becomes of paramount importance when using wires of very high tensile strength. For example, elements made of wires showing a tensile strength of the order of 270 kilogrammes/square millimetre, if made from corrugated wire as above, have idle ends totalling only about 50 diameters of the wire. If the same wire is not corrugated the idle ends total 500 diameters.

Therefore, if the elements are made, for practical reasons, with a total length of only 300 diameters, such high tensile wire could never be stressed to its full capacity if made of normal wire. However, if the elements are made of the same wire but corrugated as specified above, a length of at least 250 diameters out of the total of 300 diameters could be stressed to its full tensile capacity without pulling out the idle ends.

It follows that very high tensile wire elements can be used for Feron material without the necessity of wasting a considerable length of wire in the idle ends.

Corrugated wire elements imbedded in Feron have another important function when high tensile wire is used. Non-corrugated wire made of very high tensile steel has negligible plastic elongation and is apt to break "in succession" when the Feron material is overloaded in tension. Thus in slabs subjected to bending, the external fibres in the tension regions are broken first and the other fibres towards the neutral axis of the slab break in quick succession afterwards.

Currugated high tensile fibres provide a virtual elongation due to the minute elastic and plastic lateral compressions in the cementing compound caused by the alternating curvatures of the corrugated wire trying to stretch out in a field of tension. Thus a virtual elongation is possible in corrugated wire elements and is of an elastic nature, independent of the lack of plastic elongation of the wire.

In another form of the invention, instead of providing corrugations on the whole length of the helical elements, I provide corrugations only on the idle portions at the extremities of each element. The corrugated lengths in this case are determined by the condition that the force necessary to pull out the wire from the corrugated ends, when imbedded in mortar aggregate, should be equal to the force necessary to break the wire in tension on the non-corrugated middle portion. In this case the adhesion on the non-corrugated portion of the element will be overcome in an intense field of tension and will not play any important part when the tension in the wire reaches high values. The idle corrugated ends will act then as progressive anchorages for the middle portion. Such end-corrugations may be made with variable amplitude, greater amplitudes at the extremities gradually diminishing towards the non-corrugated portions of the helical element.

An interesting feature of this invention is that the capacity of wires to resist tension is very little affected by corrugations as specified above, provided a large number of elements are present in every direction of the Feron material. This is due to the fact that there is no freedom for an excessive deformation of the wave-shaped curve of the axis of the wire. Under a high longitudinal tension the tendency of the curve is to flatten out, but this cannot take place except if the cementing compound is crushed in a direction perpendicular to the axial direction of the wire. But such crushing cannot take place easily, there being no room for lateral expansion. What takes place is a plastic redistribution of the internal structure and stresses in the cementing compound. The final result is that after the whole material has been subjected to a substantial field of tension, when the external forces are removed, the internal structure is left in a state in which the corrugated wire elements are left under permanent tension, and the cementing compound under a permanent field of compression.

This is a great advantage as it permits the best use to be made of the respective properties of wires to take tensions and the cementing compound compressions.

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The adhesion due to corrugated elements, made as above, is of an entirely different kind than the adhesion produced by the sticking of cement mortar to ordinary wires. The difference will be made apparent at once if one will consider that such a corrugated wire will not pull out of its lodging in the mortar even if the coefficient of friction may be nil.

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As the ultimate tensile strength of Feron is directly proportional to the tensile stress of the wire, this invention gives the possibility to increase the tensile strength of Feron to the maximum possible with a minimum weight of steel wire and so at the same time allows ample space between the wire elements for the mortar aggregate.

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 as described in my Patent Specification No. 568,066 in which the helical elements are made of corrugated wires.

2. A substitute for metal castings as in Claim 1 in which the wire elements are corrugated at their ends only.

3. A substitute for metal castings as claimed above in which the wire corrugations take the form of a plane wave-like line having continuously changing positive and negative curvature.

4. A substitute for metal castings as in Claim 3 with wave-like wire corrugations having positive and negative amplitudes of the order of one half to one diameter of the wire and periods of the order of five to ten diameters of the wire.

5. A substitute for metal castings as claimed above in which at no load conditions the wire elements remain under partial tension and the surrounding cementing compound under compression.

Dated the 25th day of June, 1945.

G. CONSTANTINESCO.

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