Oct. 22, 1929. A. T. HUNTER 1,732,515

METHOD OF FORMING AN EXTENSION UPON TUBES

Original Filed Dec. 16, 1926

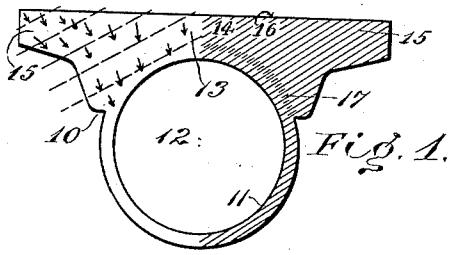

Fig. 1.

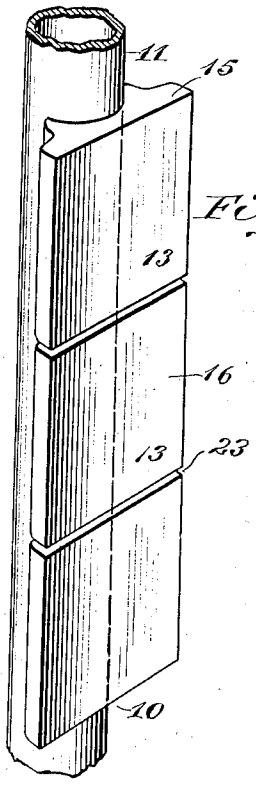

Fig. 2.

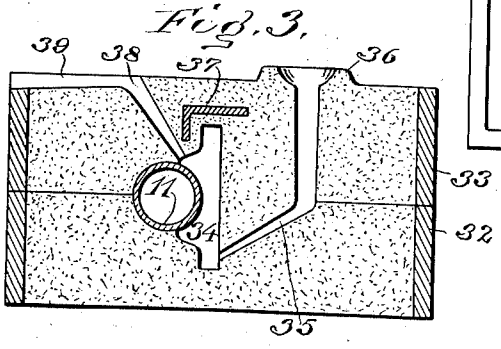

Fig. 3.

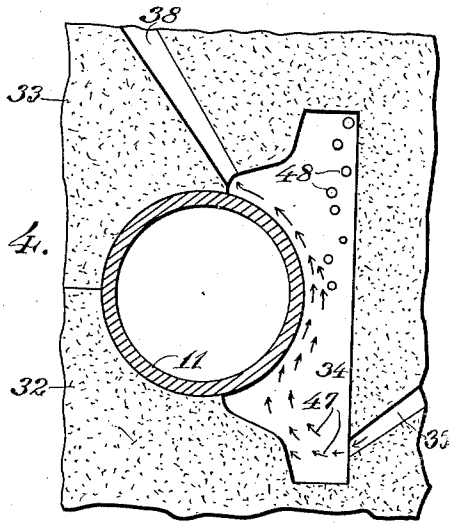

Fig. 4.

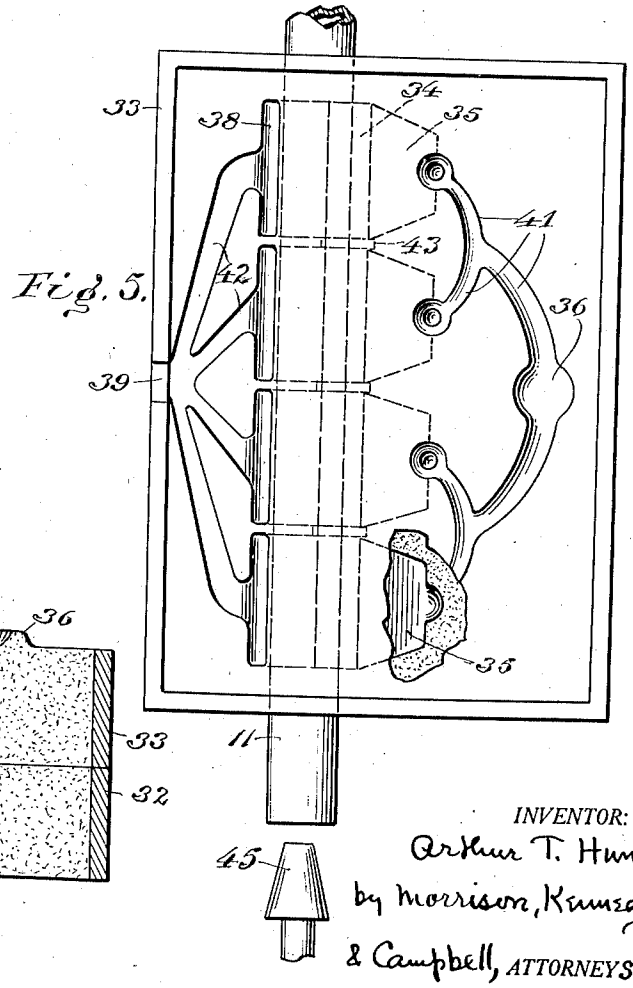

Fig. 5.

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UNITED STATES PATENT OFFICE

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METHOD OF FORMING AN EXTENSION UPON TUBES

Original application filed December 16, 1926, Serial No. 155,197. Divided and this application filed September 24, 1928. Serial No. 307,984.

This invention is a novel method of an apparatus for forming an extension upon a tube, having reference particularly to the producing of a heat transferring or integral metallic extension upon a preformed circulation tube. The present invention, constituting a division of my prior application Serial No. 155,197, filed December 16, 1926, is illustrated as used for the manufacture of wall elements for boiler furnaces and the like, especially for water walls adapted to function for the generation or superheating of steam or for keeping relatively cool a furnace wall or other exposed surface by preventing overheating due to high rates and temperatures of combustion.

The general object of the present invention is to afford a method of and apparatus for forming an extension upon a circulation tube which is practical, effective and economical and which will produce a product of high efficiency, strength and durability. Other and further objects and advantages of the present invention will be elucidated in the hereinafter following description of one or more embodiments thereof or will be understood by those skilled in the subject.

In the accompanying drawings Figs. 1 to 5 correspond with Figs. 1, 3, 6, 7 and 8 respectively of the parent application of which this is a division.

Fig. 1 is a transverse section of a circulation tube or wall element constituting an illustrative embodiment of the product of the present invention.

Fig. 2 is a perspective view showing the preferred longitudinal structure of the wall element having a cross section such as Fig. 1.

Fig. 3 is a cross section of a manufacturing apparatus by which the method of the present invention can be carried out for making a wall element such as shown in Figs. 1 and 2.

Fig. 4 is a diagrammatic partial view on an enlarged scale indicating the operations taking place in the apparatus of Fig. 3.

Fig. 5 is a top plan view of an apparatus such as is shown in Figs. 3 and 4, arranged for producing a wall element having a longitudinal structure such as indicated in Fig. 2.

The tubular wall element 10 is shown as a whole in cross section in Fig. 1 and consists of the tube portion 11 containing the water passage 12 and the exterior extension or facing 13. By water it is intended to include water either in liquid form or vapor, or other circulating fluid. The particular form of extension or facing 13 may be described as comprising a body 14 and opposite wings 15 rendering the facing substantially wider than the diameter of the tube, and the front face or surface 16 extending over the whole width of the body and wings.

As will be described the metal constituting the extension 13 is integral with the circulation tube 11, but as the tube consists preferably of different metals the drawing indicates a theoretical division, or line of union 17 between them. The complete element 10 is composed of the preformed tube 11 preferably of steel, with an integrally united or fuse welded extension 13, of ferrous metal, preferably of cast iron. The tube may be a seamless wrought steel tube of standard type as used for boiler tubes, while the extension consists preferably of gray cast iron cast directly and integrally upon the tube as will be described.

The purpose of the particular cross section form of the extension or facing and the heat transferring operation thereof as a part of a furnace or water wall are fully described in said parent application to which reference is hereby made. The desired results of transfer or conduction of heat would not be attainable under practical conditions unless the tube portion and extension are unitarily connected, and the line or union 17 therefore indicates a line of intimate or absolute contact between the two portions, with molecules or crystals interlocked continuously along the contiguous portions of the original tube and the applied extension.

The extension facing is preferably formed in relatively short sections as shown at 13, 13 in Fig. 2 instead of continuously for the length of the tube. This leaves spaces 23 between sections which facilitate manufacture and allow expansion in use of the hot sections without causing disadvantageous curving of the element and swelling of the wall. The

arrangement also allows for the gradual growth which occurs with repeated heatings of ferrous metals. While a mild steel, low in carbon, is preferable for the preformed tube, cast iron is superior for the facing, for example a gray cast iron high in carbon, and the rapid transfer of heat enables the iron to be kept from excessive temperatures. Taking a specific instance, I may use a #9 seamless boiler tube 11, having a diameter of about 3 inches, with spaces between the sections of ¼ inch, and each section about 6 inches long and a width slightly less than the spacing between the tubes, so as to leave spaces in all directions.

The water wall element, hereinabove described, may be manufactured on an economical basis by the following method. Starting with a standard seamless steel tube 11 of the desired shape and length this should first be thoroughly cleaned prior to the casting operations. It should first be dipped in pickling acid to loosen the scale, for at least half of the circumference of the tube, and this should be followed by sand blasting until the surface is bright and clean.

A portion of the length of the tube may then be inserted in a special mold such as is indicated in Fig. 3. This comprises a lower mold section 32 and above it a removable upper section or cope 33. The casting space 34 corresponds with the cross section shape of the facing extension 13 as seen in Fig. 1, and is to be formed by a suitable pattern positioned against the side of the tube 11 during the molding of the sand. A sheet gate or wide channel 35 is indicated for conducting the molten iron to the lower part of the casting recess 34, and a pouring spout 36 is arranged to connect with the gate. The sand in the cope 33 may be supported and held by gaggers 37 or other devices known to the molding art. For reasons that will appear it is preferable to arrange an exit or riser 38 for the molten iron, so that it can be poured into the mold in excess and run out through the riser and thence overflow through a gutter 39. The molten metal will be able to fill the casting space 34 to the highest point thereof due to the porosity of the sand, and the riser 38 preferably takes off from the recess 34 at a point as close as possible to the upper side of the preformed tube 11. In some cases a permanent mold might be used in lieu of the sand mold described.

The arrangement thus described may be employed for casting a single extension section 13 upon the steel tube, or by the arrangement shown in Fig. 5 may be employed for simultaneous formation of a number of such sections. The order of production of extension sections may be varied. Thus alternate sections may be cast upon the tube and subsequently others between them; or a series of sections may be cast and after the casting is cooled the tube may be shifted along for the production of another series and so on until the full desired number of sections is cast. In Fig. 5 the pouring spout 36 is shown as having multiple or divided channels 41 entering the respective sheet gates 35 for the several sections; and likewise the several risers 38 are shown delivering through separate overflow channels 42 to a common overflow point. The several casting recesses 34 may be originally formed as a single recess and spaced before casting by a series of baked cores 43 arranged between the successive sections and representing the spaces 23 shown in Fig. 2.

According to the present method the preformed tube is preferably preheated to a fairly high degree for example 800° to 900° F. so as to soften the metal or prepare it for the fuse welding operation by which the facing extensions are rendered integral with the tube. For the purpose of such preheating a burner or torch 45 is indicated and this may be used to drive through the tube flames from the combustion of oil or gas. Uniformity of preheating is desirable and I have devised an arrangement for electrically preheating the tube for this purpose. When the blow torch is used it is preferably operated alternately from one end and then the other end of the tube so as to bring the tube temperature as high and as uniformly as possible over the entire length or portion to be treated.

The casting, it will be observed, is performed directly upon the surface of the preheated tube 11. The molten cast iron may be at a temperature of about 2900° F. According to this invention the preferred operation is to allow the molten iron to fill the casting recess, and then while part of the iron flows out through the riser, keeping up a continuous flow through the gate 35, recess 34 and the riser 38, for a substantial period in order to elevate further the temperature of the steel tube, bringing it nearer to the fusion point and insuring integral uniting of the tube and extension, with molecular interlocking of the two portions of the finished product.

The diagram, Fig. 4, indicates substantially the operation. The casting space 34 is supposed to be full of molten iron. The sheet gate 35 brings the iron into the recess across the whole width thereof, while the sheet riser 38 is also of the full width, this arrangement insuring the continuous passage of a full width stream of molten iron through the recess 34 from the entrance to the exit, this stream represented by arrows 47 on the diagram. It will be noticed that the natural path of the molten iron stream is toward the surface of the steel tube and thence around such surface to the riser 38. The molten iron will be at its hottest temperature near the lower part of the tube but will maintain a substantially uniform heating effect because the arrangement causes the

stream to travel in more intimate contact with the tube as it progresses and while it is cooling.

The result is that the entire exposed and preheated surface of the tube is elevated to a fairly even temperature for integral uniting or fuse welding with the cast iron extension formed upon it. It is estimated that the tube steel, at its exposed surface, will in this process be raised nearly to, but not over 1250° to 1300° F., at which it will soften enough for welding or fusion to the cast metal, without actually melting or running.

The preferred manipulation is substantially as follows. The molten iron is poured from a ladle into the spout 36 first at a fast rate of flow in order to fill the mold quickly. As soon as the mold is filled and overflow at the riser commences, the pouring should be slowed down to as slow rate as practicable. By this plan the maximum heating up of the tube by the iron is secured with the minimum of erosion of the steel by the stream of iron. The pouring may be continued for about one minute more or less. The extent of pouring is best determined by the weight of metal and preferably several times the weight of the casting itself should be flowed through the mold. For example, in casting four facing sections, as in Fig. 5, and assuming that these will contain about 25 pounds of metal, a ladle may be employed which when filled to a certain point will hold 100 pounds of molten iron. The pouring will then be continued until all of the iron from the ladle has passed into or from the mold.

The spout 36 being at a higher level than the discharge channel 39 gravity will maintain the flow until the operation is completed. When all of the iron is poured the casting will be allowed to cool and harden and when subsequently removed from the mold will be found integrally attached to the steel tube. The extent of the operation of flowing the hot iron along the steel surface must be carefully determined. Excessive operation will cause the iron to wash away portions of the heated steel and so impair the strength of the tube. If the pouring is insufficiently continued the steel will not be brought to the welding temperature and there will be no real bond or effective fusion established between the metal of the tube and the extension. The result will be greatly impaired conductivity so that one of the main objects of the invention would be effected; and moreover the inadequately united portions are liable subsequently to separate. The operation should be so calculated as to bring the steel tube to a welding temperature, the iron thereby becoming welded and fused to the tube with a thorough union involving an intercrystalline structure. The formation of bubbles at the line of union is precluded by the described operation, since the bubbles tend to rise without having access to the surface of the steel tube, as indicated at 48 in Fig. 4.

Many variations suggest themselves. Thus by a suitable elongated mold an entire twenty foot tube can be treated in one operation. The tube may be of any nature suitable to its purpose, and the facing or extension is not necessarily of cast iron but may be cast steel.

The described molding and casting method may be improved and quickened as follows. The mold portions containing the gates and risers may consist of previously prepared hard-baked dry sand cores, and the runner and pouring spout may likewise be composed of baked sand and located directly on top of the baked core members. After the tube is placed in the mold the baked cores defining the facing extension are placed against the tube, and then green sand is placed to surround the tube and cores and tamped tightly, before the pouring of the measured amount of molten iron as already described. This system reduces errors and losses, and makes all castings uniform; and accidental entry of dirt into the mold is prevented. The molding time is shortened, and the molding requires less skill. The output from each mold is increased, since one set of men may be employed in making the separate baked cores, while another set is applying cores and forming the molds. The larger output is therefore accompanied by lower cost of production. The small cores separating the casting into longitudinal sections may advantageously be composed of cast iron, and they may be pasted and covered with sand before being applied at the mold; this giving a cleaner separation between sections, and giving a more uniform result as the cast iron core is not subject to crushing; and it is readily knocked out after the cooling and removal of the product.

Features disclosed but not herein claimed are reserved for claim in copending application Serial No. 309,844, filed October 2, 1928.

There has thus been described a method of forming an extension upon a tube embodying the principles and attaining the objects of the present invention. Various matters of method, operation, combination, arrangement and structure may be variously modified without departing from the principles and therefore it is not intended to limit the invention to such matters except to the extent set forth in the appended claims.

What is claimed is:

1. Apparatus for applying at one exterior side of a preformed tube an integral extension, comprising a mold adapted to receive a section of the preformed tube with its end or ends projecting externally, and said mold having mold material defining a casting space of the shape of the extension at one side of the tube while protecting the remainder of the tube, and having a gate for

delivering molten metal into the lower part of the casting space, and an exit passage from the upper part of the space to an overflow point.

2. The method of forming upon one side of a preformed ferrous metal circulation tube an integral heat-absorbing extension of ferrous metal, comprising supporting the tube in position in a mold with its side that is to receive the extension exposed in a casting space of the shape of the extension, and with the remainder of the circumference of the tube protected by the mold material, flowing molten ferrous metal into and through the casting space in excess quantity, continuing such flowing until the tube metal attains welding temperature at its exposed circumference, then stopping such flowing before melting of the tube metal or substantial interflowing of metals, and allowing the extension metal to solidify under confinement to the shape of the extension; whereby integral union is effected of the similar metals of the preformed tube and the produced extension.

3. The method of forming upon one side only of a preformed metallic circulation tube an integral heat-absorbing extension of similar metal, comprising supporting the tube in position in a mold with its side that is to receive the extension exposed in a casting space of the shape of the extension, and with the remainder of the circumference of the tube protected by the mold material, applying heat internally to the tube to heat the walls thereof both at the side exposed in the casting and at the opposite side, flowing molten extension metal into and through the casting space in excess quantity, continuing such flowing until the tube metal attains welding temperature, then stopping such flowing before melting of the tube metal or substantial interflowing of metals, and allowing the extension metal to solidify under confinement to the shape of the extension.

4. The method of forming upon one side of a preformed wrought steel circulation tube an integral heat-absorbing extension of cast iron, comprising supporting the preformed tube in substantially horizontal position in a mold with its side that is to receive the extension exposed laterally in a casting space of the shape of the extension, and with the remainder of the circumference of the tube protected by the mold material, flowing molten cast iron continuously into and through the casting space in excess quantity, continuing such flowing until the tube steel attains welding temperature, then stopping such flowing before melting of the tube steel or injurious erosion thereof, and allowing the extension metal to solidify under confinement to the shape of the extension.

5. The method as in claim 4 and wherein between a quarter and a half of the circumference of the preformed tube is exposed in the casting space, and the molten iron is admitted to a low part of the space so as to flow upwardly and to overflow from a higher point proximate to the surface of the tube.

6. Apparatus for applying along one side of a preformed tube a series of integral extensions, comprising a mold adapted to receive horizontally the preformed tube and defining a series of casting spaces of the shape of the extensions at one side of the tube, with separating cores between the spaces, and gates for delivering molten metal into the lower part of each casting space, and exit passages from the upper part of each space to an overflow point.

7. Apparatus for applying at one side of a preformed tube an integral extension, comprising a two part mold adapted to receive the preformed tube horizontally between the mold parts and defining a casting space of the shape of the extension at one side of the tube, and having a gate delivering into the lower part of the casting space at a point distant from the tube, and an exit passage leading from a point closely adjacent to the tube in the upper part of the space.

In testimony whereof, this specification has been duly signed.

ARTHUR T. HUNTER.