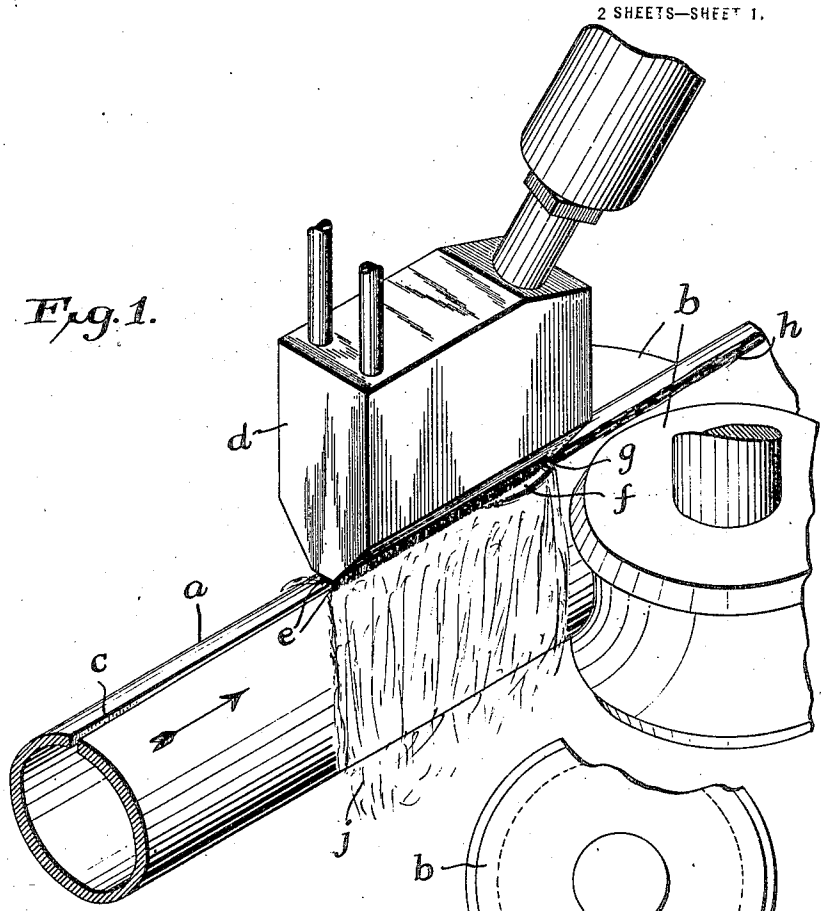
J. L. ANDERSON.
METHOD OF WELDING.
APPLICATION FILED AUG. 13, 1919.

1,402,997. Patented Jan. 10, 1922.

2 SHEETS—SHEET 1.

Fig. 1.



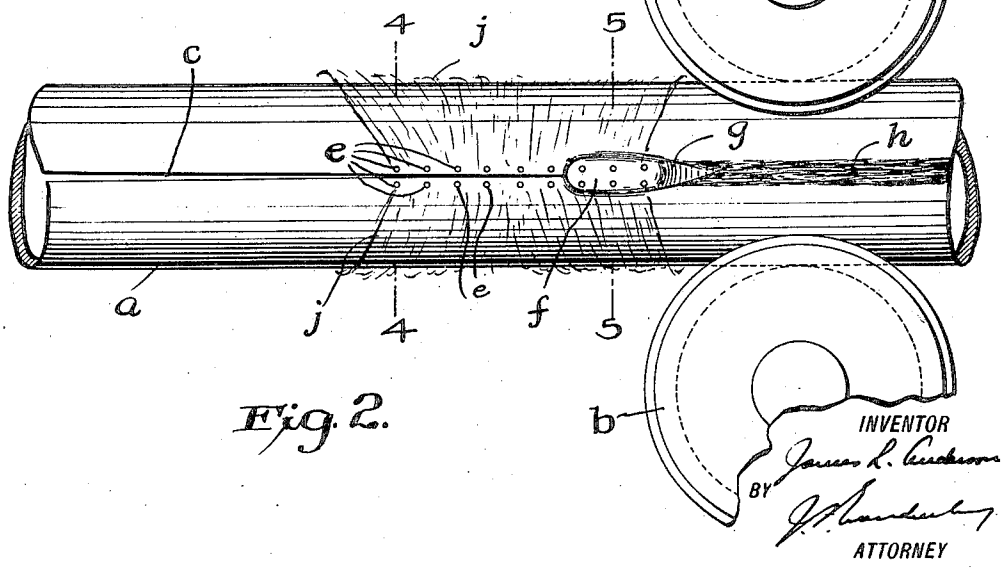


Fig. 2.

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2 SHEETS—SHEET 2.

Fig. 3.

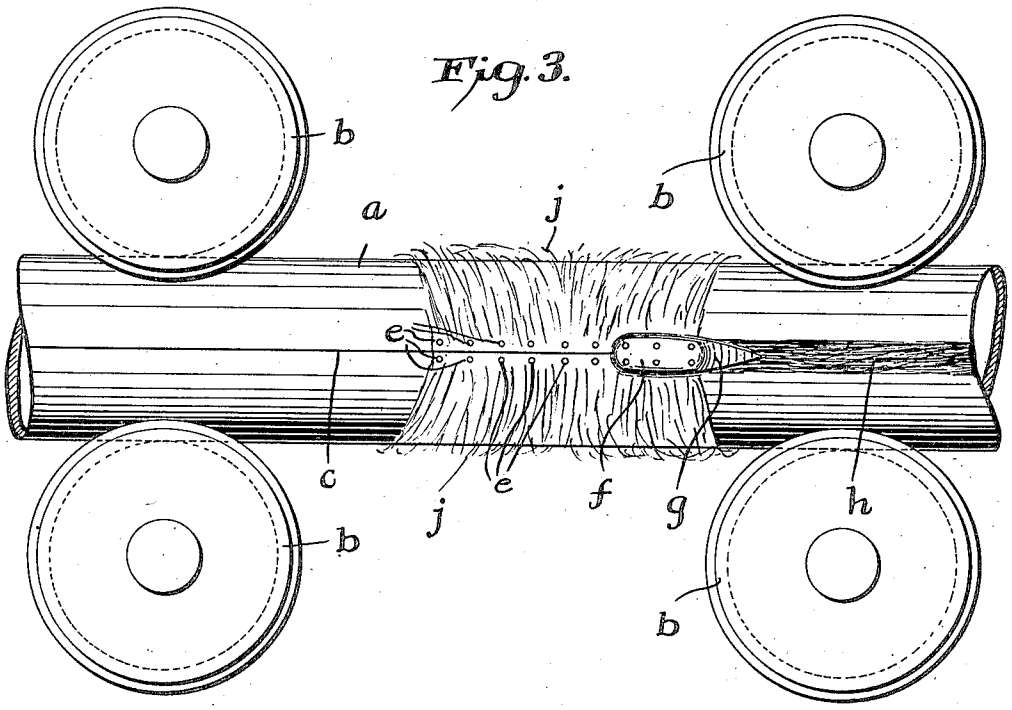


Fig. 4.

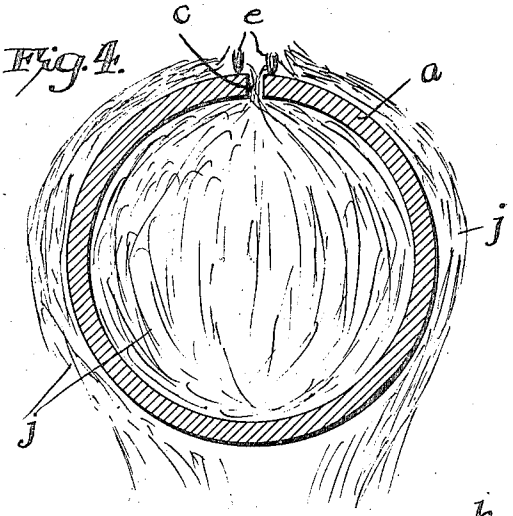
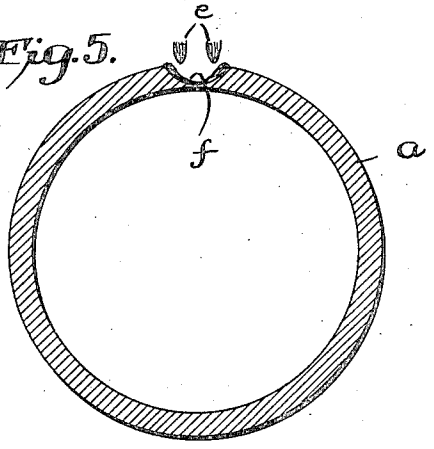


Fig. 5.



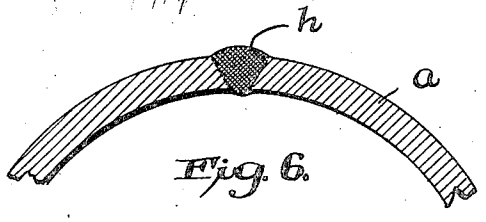


Fig. 6.

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UNITED STATES PATENT OFFICE.

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METHOD OF WELDING.

1,402,997. Specification of Letters Patent. Patented Jan. 10, 1922.

Application filed August 13, 1919. Serial No. 317,281.

To all whom it may concern:

Be it known that I, JAMES L. ANDERSON, a citizen of the United States, and resident of Bayonne, in the county of Hudson and State of New Jersey, have invented a new and useful Method of Welding, of which the following is a specification.

The invention relates to the production of autogenously butt-welded longitudinal seams by the oxyacetylene flame. In the manufacture of welded tubing as commonly practised, the torch or blowpipe is stationarily supported, and the tubing is driven lengthwise by rolls, with its seam at a suitable distance beneath the flame, so that the latter progressively fuses the edges, the molten metal of which flows together and solidifies behind the flame in a continuous cast union. In order to secure speed it was recognized that more than a single jet should be employed, and from two jets in tandem it has become customary to employ a larger number of jets extending for a substantial distance in the line of the weld. In thus extending the heating zone lengthwise it has been thought important to confine it transversely as narrowly as possible to the extreme seam edges, and the development has been in the direction of a long series of fine jets so located, i. e., centralized with the crevice. In such cases the seam edges are heated largely by convection, and a part of the heat which it is sought to deliver by the high velocity jets, directly to the portions to be united, to the exclusion of the regions behind the edges, is lost by striking through the crevice. If particularly high pressures are used, as is sometimes desired or may happen inadvertently, this action may also result in establishing a path for the fused metal, which then flows down through the seam, leaving a gap which will not fill up, or a region with insufficient metal, a form of defective weld which is not uncommon. The purpose of the present process is to obtain stronger welds with less difficulty and danger of defect and with equal or greater speed and with economy of gases. This is accomplished by spreading or distributing the heating at opposite sides of the center line or plane of the seam, as by two adjacent rows of jets, which play back of the edges, directing the main portion of the flame to the metal at opposite sides of the crevice. Thereby the intense heat of the inner cones of the jets is applied more effectively to the parts to be united, loss of working heat by escape of gas through the seam and injury to the weld are avoided, and the welding is effected largely by radiant heat between the jets. The intense heat is spread laterally even more widely than in the simple case of a single round jet. The section of the welded joint produced in this way is wider and stronger and more certain to extend through to the opposite side than is the case with the narrow weld made by a central line of flame; and the work is performed more rapidly with smaller consumption of gases, in proportion to the output. With the central line flame it is difficult to keep the heating on the seam, and weakened welds resulted from slight lateral deviations, which owing to the narrowness of the downwardly tapering heated section caused the seam to be united only at the top or for part of the depth, leaving it open in the interior of the tube. The present invention makes exact alinement unnecessary, and enables complete penetration to be obtained with less difficulty and at greater speeds than heretofore. Furthermore, in welding heavy metal with the single line of flame, the metal is likely to set without flowing, resulting in a weld unfilled at the sides and of inferior strength. This difficulty is overcome by the present method, wherein the heating is carried back of the edges, and the wave of molten metal, which proceeds along the seam toward the rear of the flame and flows inward, is of large dimensions, and has a desirable tendency to pile up in the crevice so as to give a full weld along the crevice even thicker than the original material. Needless to say, the double rows of jets are shorter than a single line of jets would have to be if used in an attempt to get similar speed and penetration.

In practising this method of welding, if there is a common condition of the seam being held closed by rollers adjacent the welding point and spreading somewhat apart in advance, the leading jets of the rows will play on or about the edges, and the rear jets, by which the actual or final welding is performed, will be back of the edges, the lines of the jets thus relatively diverging acutely from the edges from front to rear. In this connection, the double row of jets

permit welding with a comparatively wide gap, which is desirable in some cases, and tends to produce a welded seam which is not substantially thicker than the original metal. If the edges are held in contact substantially throughout the length of the rows, practically all of the jets will be back of the edges. These are typical conditions, from which there may be many variations. Thus, there may be more than two rows of jets, the rows need not necessarily be straight or parallel, in some cases single and double rows may be combined, or single jets and pairs of jets in alternation, or, finally, continuous flames from slit-form jets, as distinguished from a series of point jets, may be employed. In any case the method involves progressively heating and welding the edges by autogenous jets closely straddling or spanning the seam, while producing continuous relative movement between the longitudinal seam and the jets.

While the inner working portions of the jets at opposite sides of the center line are not permitted to carry through the seam, the central part of the envelope of the flame may and will do so wherever the seam is somewhat open, thereby filling the interior of the tube for several feet with a diffused blue preheating or annealing flame of useful character. Such envelope filling the interior of the tube and being of a reducing character prevents the oxidation of the inner portion of the seam which commonly occurs, and thereby contributes in an important measure to greater strength of the weld. Tubing welded in this way is found to be bright inside, instead of blackened, as usual. Exteriorly, the envelope, because of the insufficient access of atmospheric oxygen between the rows, flows laterally around the tube, spreading forwardly and rearwardly, affording greater benefit in the way of reducing conduction losses than is ordinarily obtained from the envelope in welding. Because of the annealing action of the envelope it is possible to dispense with a separate annealing operation prior to subsequent mechanical treatments, in the case of hot-rolled or single-pass cold-rolled stock.

In the accompanying drawings:

Fig. 1 is a perspective view illustrating tubing being welded in accordance with the invention;

Fig. 2 is a semi-diagrammatic plan view, showing the relation of the jets to converging seam edges, the large wave of molten metal, and the spreading of the envelope;

Fig. 3 is a similar view, showing a seam with its edges abutting throughout the heated length;

Fig. 4 is a cross-section on the line 4—4 of Fig. 2, showing the envelope projected through the open seam and surrounding the tube;

Fig. 5 is a cross-section on the line 5—5 of Fig. 2, showing a wide cavity which may be formed toward the rear, from which the molten metal in a broad wave flows around and piles up between and behind the jets above the original level; and

Fig. 6 is a cross-section of the completed weld; the views being schematic.

In Fig. 1 the tube *a* is traveling in the direction of the arrow between the horizontal rollers *b* carrying its seam *c* beneath the jets of an oxyacetylene or like torch *d* located slightly in advance of the rollers. The torch may be of a variety of forms, a number of which are shown in my copending application Serial No. 317,282 filed August 13, 1919, the one herein represented being designed to deliver two adjacent parallel rows of small preheating and welding jets *e*. These jets may be delivered either vertically or at a forward inclination, or, as illustrated in my said application, continuous lines of flame issuing from slits may be employed. The seam edges in this instance converge from an open to a closed condition beneath the jets as they approach the confinement of the rollers *b*, with the result that the lines of flame diverge slightly from the edges from front to rear. In this case the forward preheating jets play upon the borders of the seam, or very close thereto, so that the action of the jets is first upon the edges of the metal and thereafter progressively removed therefrom, until at the rear the jets are definitely back of the edges, which have now been brought together and are in a state of fusion. In Fig. 3 the edges are held together or in close parallelism throughout the portion of their travel beneath the torch, so that the flames act back of the edges throughout their longitudinal extent. In either event a relatively wide, intensely heated section is produced, involving the tube walls at both sides of the seam. This section fuses beneath and within the rear part of the flame, forming a characteristic long and broad wave *f*, *g* composed of the metal of the material displaced by the jets of the rear third, more or less, of the spread flame, said metal flowing around the jets and finally accumulating behind the flame, where it continually solidifies to form the full and raised weld *h* of Fig. 6.

In general, the purpose of this invention, in contradistinction to the prior practice wherein the aim has been to localize the intense heating as much as possible along a line, is to establish a longitudinal zone of confined or accumulated heat which embraces the borders of the seam, this being accomplished by delivering the heating mixture in the form of a longitudinally-extending transversely spread collection of fine or narrow jets covering or defining a strip-like area on the top of the tube. Under these conditions the heating, fusing and uniting

of the metal take place in a new manner as above described, and the weld obtained is distinguishable from ordinary welds. The weld produced by a line flame is really carried through by the pneumatic action of the gases, while with the present process this maximum pressure is not directed into the crevice, but upon the solid metal at either side, which allows the weld to be produced by radiation and conduction, melting two bodies of metal which unite in one. Consequently a perfect autogenous union is obtained, and thorough penetration results without danger of the gases blowing in the molten bridge. It is very difficult, in mechanical seam welding,—referring particularly to tube-welding,—with a single row of jets, to maintain or produce a region of fusion of sufficient area and depth to weld completely, without having the metal forced through in holes. Not infrequently such welding amounts to melting the upper portions of the edges and driving the material therefrom into the lower part of the crevice; and a premature bridging across of the uniting material tends to limit penetration. The obtaining of a good welded product requires a very close adjustment and delicate balance of the factors of heat-delivery, conduction, and speed of longitudinal travel, and, of course, alinement. With my process, on the contrary, a given point on the open seam, as it reaches the forward end of the zone of high temperature and then travels through and past the same, is progressively heated by radiation and conduction from both sides, with the result that there is a section of intense heating in the metal, transverse to the seam, which grows wider and deeper until the whole depth is involved in fusion. The region of fusion, being surrounded by the jets and protected by the reducing atmosphere of the interior portion of the envelope of the jets, is not subject to oxidation or to the formation of nitrates from the nitrogen of the air.

By applying the jets at opposite sides of the seam the conduction of heat in the metal is toward the edges, where it is arrested by the air gap and can only proceed downward, so that the temperature of a large section is raised very rapidly to the fusion point. With the central line of jets, on the other hand, conduction is away from the edges, and as a weld cannot be produced until enough heat has been absorbed by the surrounding metal to lessen subsequent conduction to a point where the continued application of the flame produces a penetrating effect, the progress from first preheating to final welding is much slower than in my case, and the loss of heat greater. Thus, with a double row of jets straddling the seam, of materially less length than a single row that might be used for the same work, and each jet materially smaller, so that the total collection consumes a small amount more of gas per unit of time, I am enabled to weld at greatly increased speed of travel of the tubing through the machine, with consequent increase in output, and with smaller consumption of gas as measured by the output, obtain a superior product, possessing different qualities from tubing welded in the ordinary way, reduce defective welds from a high to a low percentage, and materially reduce the demand upon the skill and vigilance of the operator. The weld can be left substantially as a cast union, or can be worked in the usual manner by pressure applied through the rollers, to which it lends itself particularly, the pressure being applied at a distance in rear of the welding region, sufficient to enable the metal to cool to the critical point at which it regains its strength.

The invention has been described for convenience in terms of a double longitudinal row of jets, which is the typical and preferred grouping, but numerous other, similar, though specifically different, forms and arrangements of jets may be employed in the same general manner and with the same substantial result, a number of such modifications being illustrated in my copending application referred to.

The active part of the flame comprises the small cones *e*. The large envelope of lower temperature, wherein the secondary combustion takes place, is designated *j*. A portion of this envelope between the jets flows through the open part of the seam and fills the interior of the tube with preheating or annealing flame. This flame, composed of hydrogen and carbon monoxide burning in the oxygen of the air in the confined interior of the tube, is actively reducing, and prevents the oxidation and consequent weakening of the weld on the inside which have heretofore occurred. On the contrary, the interior line of the weld comes out bright. The diffused flame or the superheated unconsumed gases of the envelope will flow through the interior of the tube for thirty feet or more seeking the end, and serve to preheat or anneal or both. Exteriorily, the tendency of the compound envelope, as explained is to spread laterally and to bathe the outside of the tube for a length embracing the region which is acted upon by the jets.

While the invention has been described with particular reference to the welding of tubes, it may be applied also to welding abutting edges of other parts, either flat or curved.

What I claim as new is:

1. The method of butt-welding longitudinal seams which comprises progressively heating and fusing the opposed regions of a

seam by the application of a longitudinally extending, transversely spread group of jets creating a region of confined intense heating whereby a substantial section is brought quickly to fusion, while continuous relative longitudinal movement is produced between the seam and the jets, substantially as set forth.

2. The herein described improvement in the art of progressively butt-welding longitudinal seams by fusion with the autogenous welding flame jets which is characterized by the application of the intensely heated points of the jets back from the edges of and at opposite sides of the seam, while continuous relative longitudinal movement is produced between the seam and the jets, substantially as set forth.

3. The method of longitudinally butt-welding tubing by means of a plurality of autogenous welding flame jets, which comprises heating and fusing the edge parts by applying the intensely heated points of the jets entirely or largely to the metal at regions back from the edges of and at opposite sides of the seam, while the reducing gases of the envelope from between the transversely spaced jets are caused to enter the interior, substantially as set forth.

4. The method of butt-welding seams by a plurality of flames, which comprises directing the intensely heated points of the flames upon the metal a short distance back from the edges of the seam and at opposite sides thereof, and thereby causing the margins to fuse and flow together.

5. The method of progressively welding tubing by a plurality of jets, which comprises delivering the intensely heated points of the welding jets at regions spaced slightly back from the edges of and at opposite sides of the seam so as to fuse the metal of the edge portions and cause them to flow together.

6. In the art of progressively welding seams by a plurality of autogenous welding flame pressure jets, the improvement which comprises attacking the metal by the intensely heated points of the pressure jets at regions slightly removed from the edges and at opposite sides of the seam, and thereby heating and fusing and flowing together a section including the edges without substantial pressure in the line of the crevice.

7. A method of progressively butt-welding seams by the application of the intensely heated points of rows or lines of autogenous welding jets at places removed from the edges and at opposite sides of the seam, and thereby fusing the edge regions and causing them to flow together.

JAMES L. ANDERSON.