April 8, 1930. A. C. ANDRESEN 1,753,677

METAL WORKING PROCESS AND APPARATUS

Filed Aug. 7, 1926 3 Sheets-Sheet 1

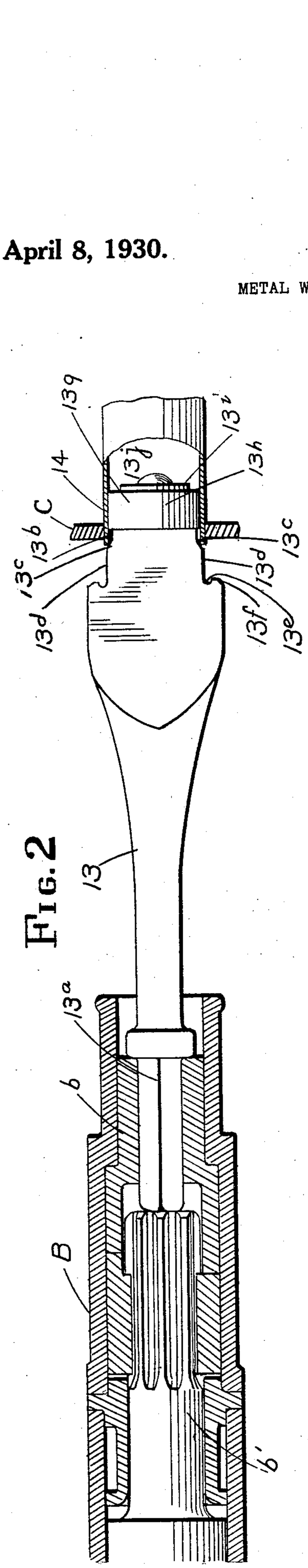


FIG. 2

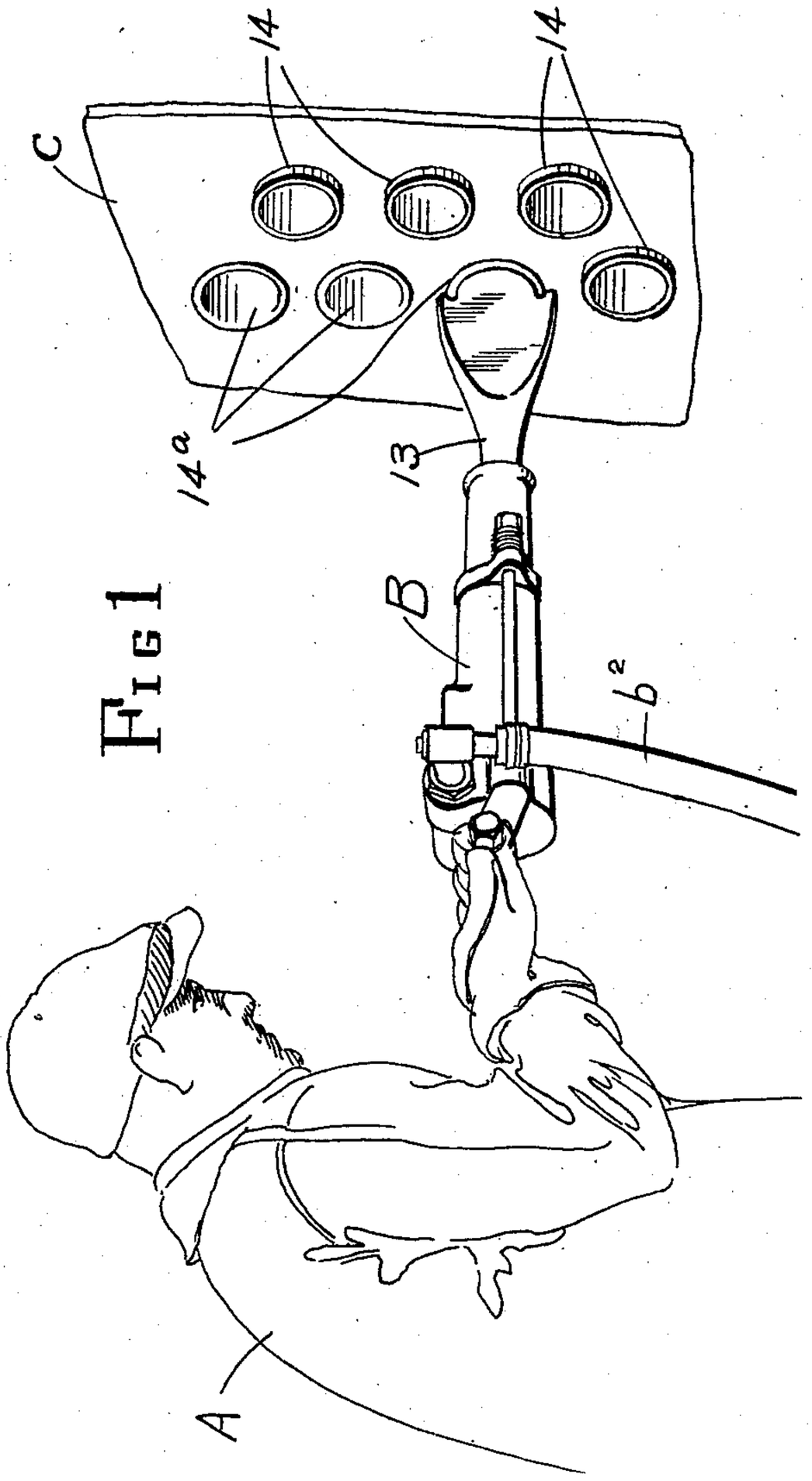


FIG 1

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FIG 3

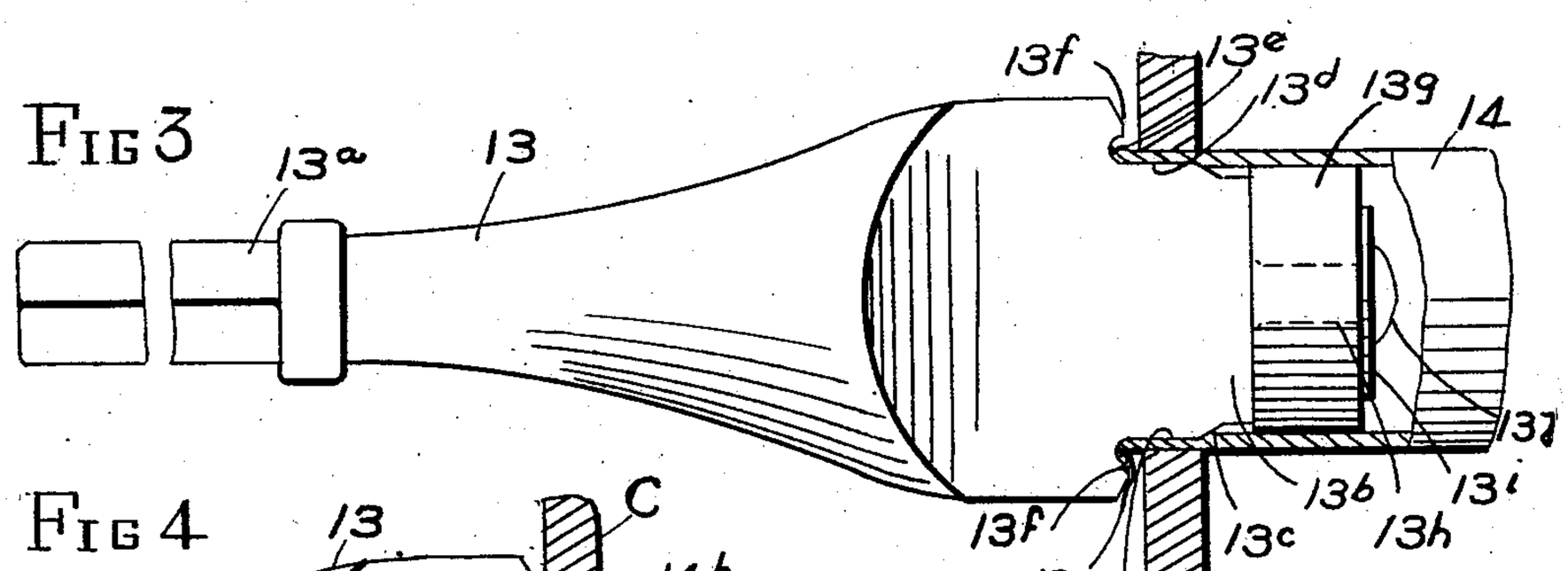


FIG 4

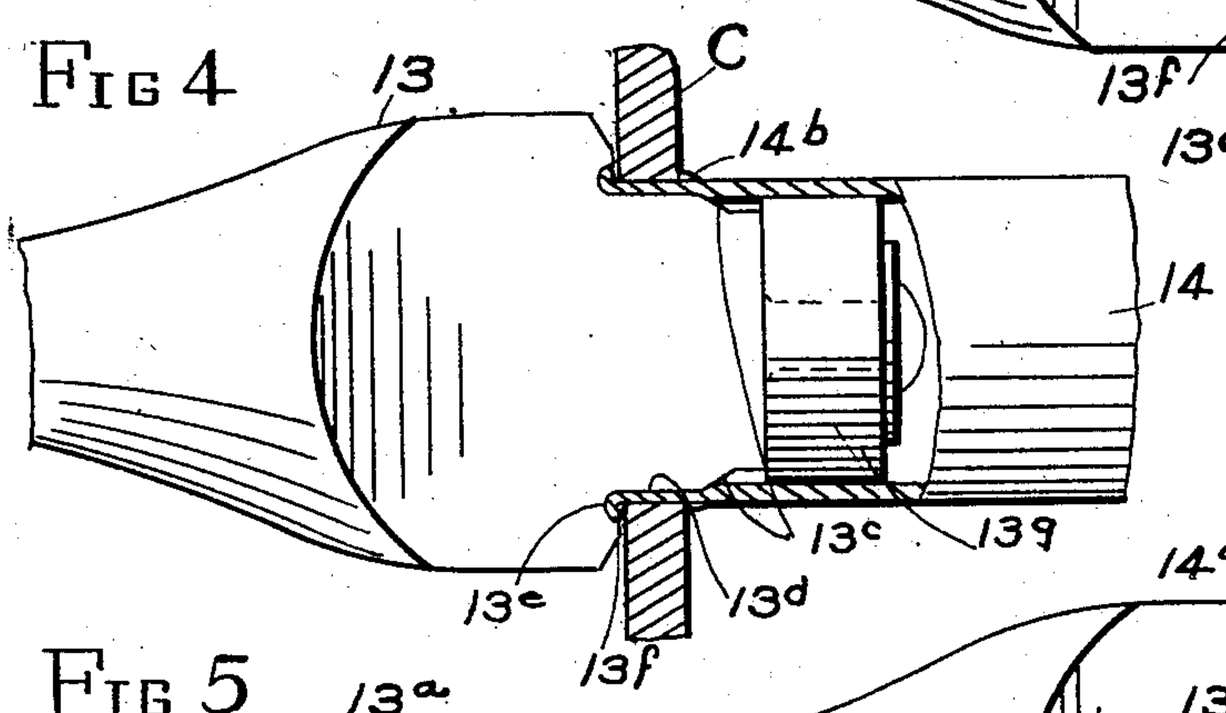


FIG 5

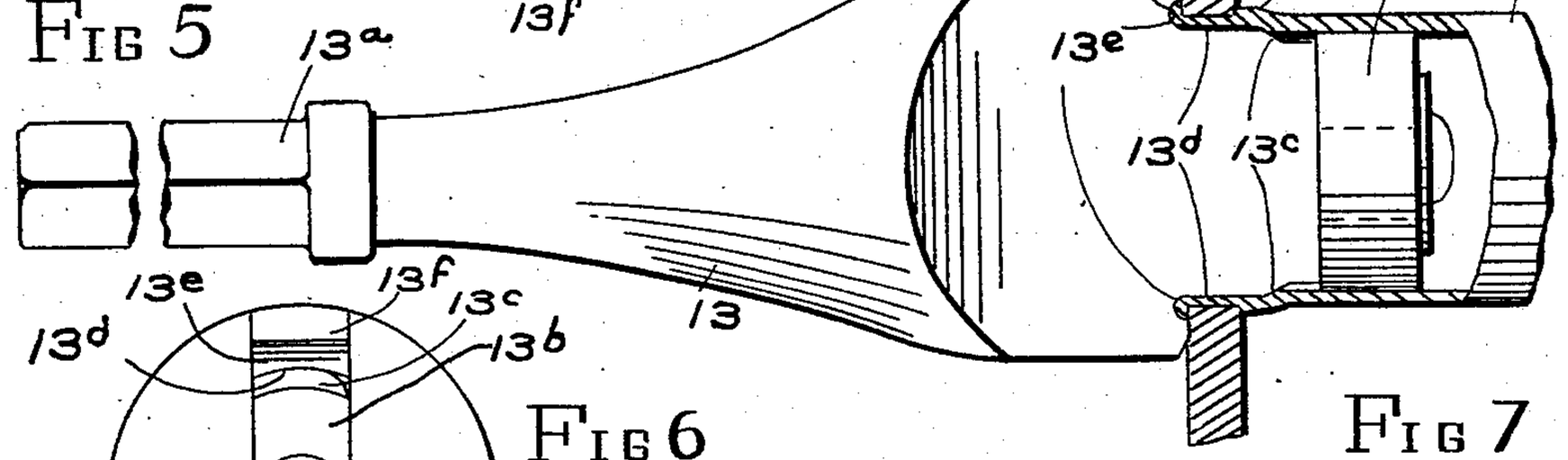


FIG 6

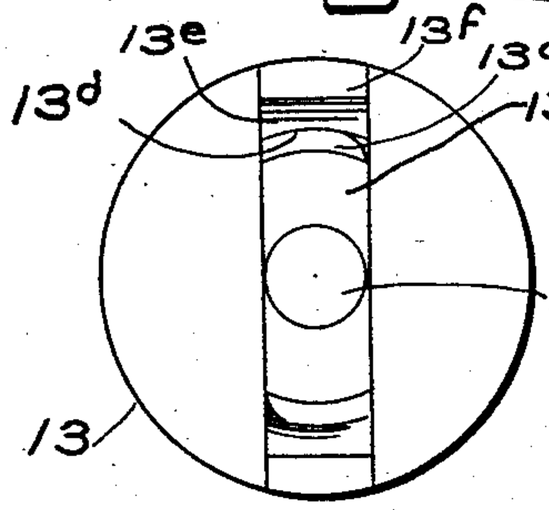


FIG 7

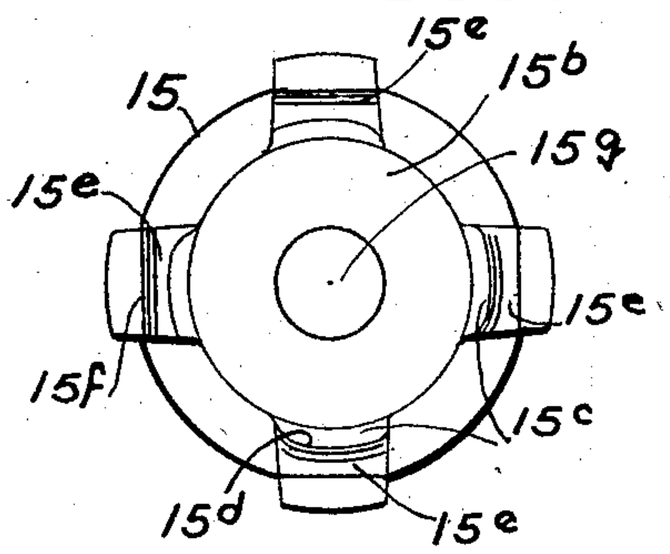
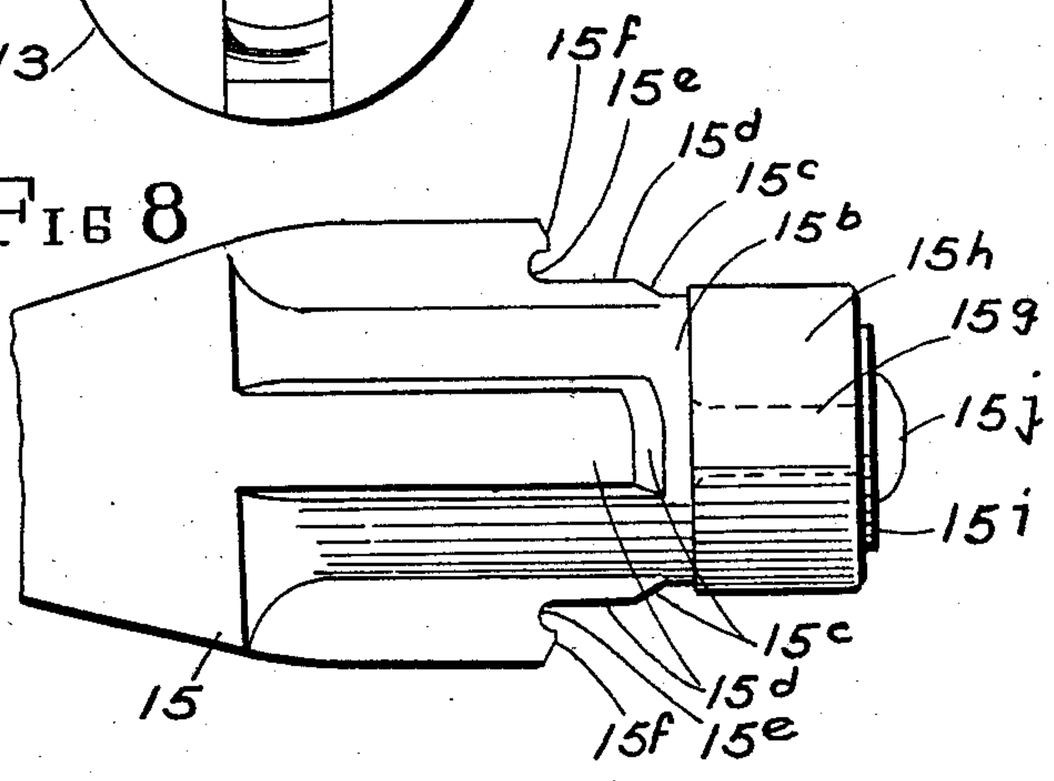


FIG 8



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METAL WORKING PROCESS AND APPARATUS

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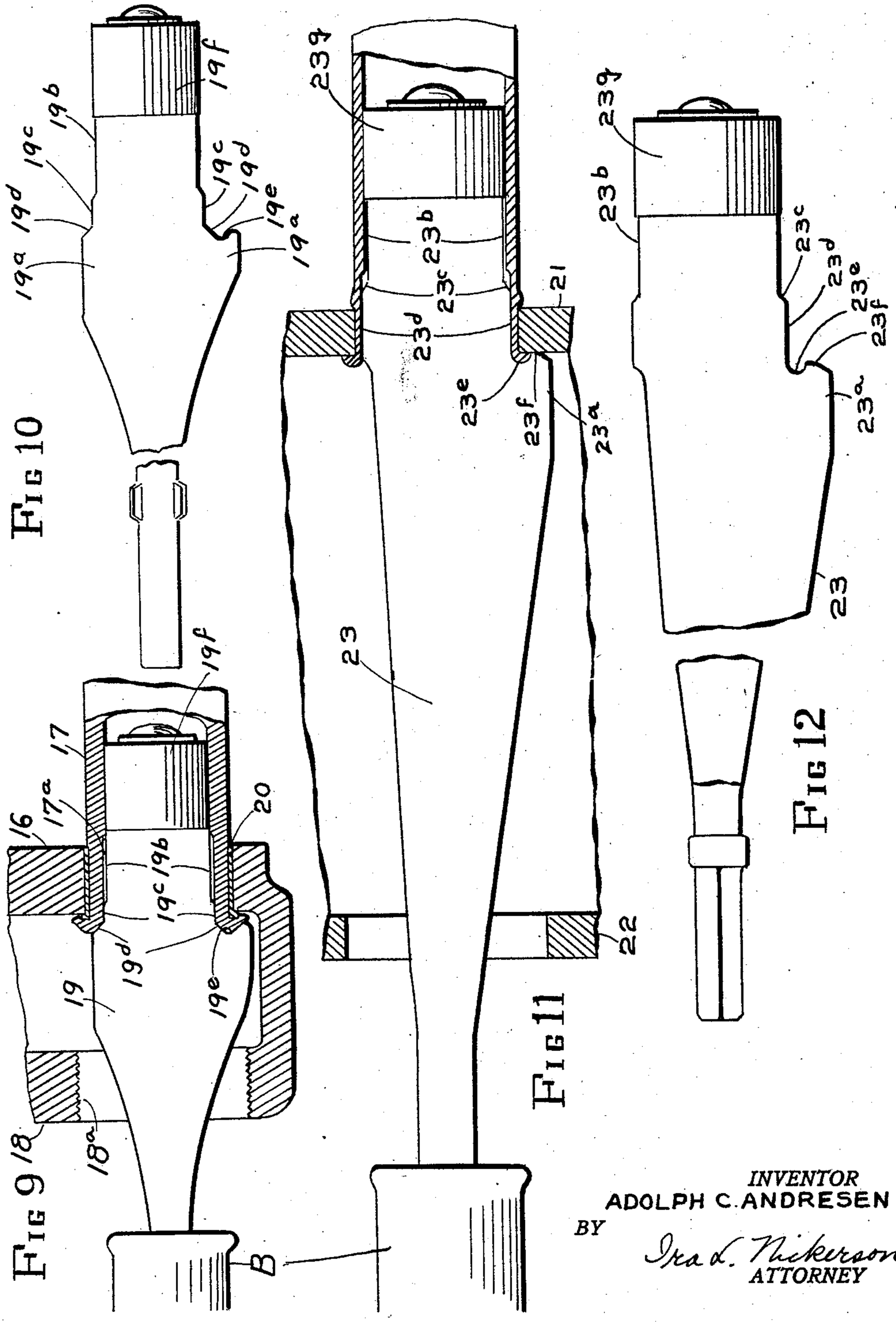


FIG 10

FIG 11

FIG 12

FIG 9

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UNITED STATES PATENT OFFICE

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METAL-WORKING PROCESS AND APPARATUS

Application filed August 7, 1926. Serial No. 127,732.

This invention relates to metal working and includes both process and apparatus. In particular it relates to the installation or securing of tubular members in apertured heads such as in tube or flue setting for boilers, stills, etc.

Processes heretofore in use have been characterized by a large expenditure of physical labor and several separate steps or operations. In boiler making, for example, in the installing of a tube the first step is to roll the interior of the tube so as to expand it into contact with the walls of the head opening. The outer projecting end of the tube is then flared either by a separate tool or as the part of the rolling step. The flared end of the tube is then formed into a bead by means of a manually directed tool for this purpose operated by a pneumatic hammer. The tube is then given a finishing roll to complete the work. It is thus apparent that much time is consumed and several tools are required for this work. All the tools used are manually directed and the success of the work depends entirely upon the skill of the workman. Even with the greatest care on the part of the most skilled workman there is a tendency to thin the wall of the tube at the turn of the bead, with the result that the tube is weakend at this point. In fact, any tube put down by hand methods such as heretofore practiced, when sectioned will be found to have a wall of varying and irregular thickness at and adjacent the bead. In order to remedy at least in part the difficulties of such methods it is customary to line the head opening with a ferrule of soft metal such as copper in order to assist in securing a tight joint.

In the construction of stills used in the so-called "cracking" processes in the refining of petroleum, the difficulties encountered in boiler and ordinary still work are greatly magnified for the reason that the trade is demanding in the interests of economy larger and larger stills with very heavy walls in order to delay and postpone the inevitable replacements and repairs which must be made on account of the rapid corrosion or burning out of the metal of the stills. At the present time "cracking" stills are being made with steel tubes having an inner diameter of 3 to 4 inches and an exterior diameter of 4 to 5 inches, the walls of the tubes being ½ inch thick. Present methods of installing such tubes require the use of the heaviest portable tool equipment obtainable, and additional operative steps by reason of the thickness of the walls of the tubes worked upon, including heating the tubes to make the metal more ductile, also a large crew of men is required by reason of the extremely laborious nature of the work. Such stills usually have an outer wall or head spaced from the flue head and the work must be performed through small hand-openings in the outer wall, which makes the work still more difficult to perform and to check by inspection.

Among the objects of the invention are to improve the quality of the work and to reduce the labor, time and expense of securing tubular members in place. Another object is to perform the flue setting operations, or any desired number of them, in one continuous operation. A further object is to eliminate entirely the heating of heavy tubes. A still further object is to simplify the work and to reduce the number of men required to perform it. Still another object is to reduce the mechanical equipment required. A still further object is to avoid the difficulties of prior methods and to improve the resistance of the joint to pressure, corrosion and strains. Other objects will be apparent from the detailed description which follows:

In one aspect the invention consists in an improved process by which all or most of the steps of the usual method are performed with very little manual labor and with a greatly reduced force of men. In practicing the process the end of the tube and its interior is subjected to a continuous operation involving both percussion and rotation. It further consists in impacting the tube metal into the walls of the head opening to insure a tight joint. This may be accomplished by maintaining the tube walls at and adjacent the bead of uniform thickness while the end of the tube is subjected to percussion. It avoids thinning and weakening the tube adjacent the head as when ordinary hand-meth-

ods are used. The invention further consists in suitable apparatus for producing the above results. The actual working tool may take the form of a relatively thick flat member with two or more tube engaging portions arranged to enter the tube and to receive a large number of heavy blows per minute and to be rotated at the same time so that a spinning, ironing, or rolling effect is produced upon the interior of the tube.

The invention is illustrated by the accompanying drawings in which:

Fig. 1 is a perspective view of a workman putting down a boiler tube in accordance with the improved process;

Fig. 2 is a fragmentary view on an enlarged scale of the apparatus shown in Fig. 1, a portion of the boiler head and tube being shown in section, also a portion of the percussive and rotative machine, while the working tool is shown in side elevation entering the tube;

Figs. 3, 4, and 5, are fragmentary views similar to Fig. 2, but on an enlarged scale illustrating stages in the process of setting the tube;

Fig. 6 is a right hand elevational view of the working tool shown in the previous figures with the pilot member removed;

Figs. 7 and 8 are respectively a right hand elevational view and a side elevational view of a modified form of tool;

Fig. 9 is a sectional view through the wall of a still illustrating a modified form of tool;

Fig. 10 is a side elevational view of the working tool shown in Fig. 9;

Fig. 11 is a view similar to Fig. 9 illustrating the process as applied to the setting of tubes in a Burton still;

Fig. 12 is a fragmentary side elevational view of the working tool shown in Fig. 11.

Fig. 1 illustrates the improved process wherein the operator A is directing a percussive and rotative machine B provided with a working tool 13 in the setting of tubes in a boiler or still head C. Tubes 14 have been placed in the apertures therefor in head C preparatory to being secured therein, certain of the tubes being shown with a completed bead at 14^a.

Machine B may be of any suitable or desired type; it is provided with a rotatable chuck b in which the shank end 13^a of the working tool 13 is inserted (Fig. 2) to receive the blows of a percussive member such as piston b' while the chuck b is rotated either continuously or intermittently by any known or suitable apparatus actuated as a result of the reciprocatory movement of piston b' or independently thereof. The percussive and rotative machine B illustrated is of the fluid pressure type supplied with motive fluid through a suitable conduit b^2.

One form of working tool and the steps of the continuous process by which tubes 14 are secured in head C are illustrated in Figs. 2 to 6 inclusive. The working tool 13 as shown in side elevation in Fig. 2 and in front end elevation in Fig. 6 has a shank 13^a extending within the percussive and rotative machine, and its forward end is flattened and provided with integrally formed portions or surfaces for acting upon the tube. The extreme forward end 13^b of the tool is sufficiently reduced to permit its easy entrance into the tube followed by the diametrically opposed expanding surfaces 13^c. The expanding surfaces are followed by the tube holding surfaces 13^d, after which come the beading sockets 13^e terminating in stops 13^f. The leading edges of the expanding and holding surfaces are beveled as indicated in Fig. 6. In order to maintain the tool in proper alignment with the tube as it is forced within the latter, and to prevent possible interference with the rotation of the tool through side movement and cramping, a suitable pilot is preferably provided at the front of the tool, this pilot being omitted in the end elevational view Fig. 6 for the sake of clearness. The pilot may take the form of a cylinder 13^g loosely fitting the interior of the tube and either rotatable upon or permanently fixed to a reduced extension 13^h of the tool. If the pilot is rotatably mounted it should be secured to extension 13^h in a manner to resist the heavy vibration resulting from the operation of machine B which tends to shear off cotter-pins and similar securing devices. A preferred arrangement is to apply a washer 13^i and then form the end of the extension into a rivet head 13^j. If the pilot is to be a permanent part of the tool it may be fashioned initially as an integral part of the tool or be secured there-to in any suitable manner as by welding.

The steps of the process are clearly shown in Figs. 2, 3 and 4. Fig. 2 shows the working tool 13 just being inserted within the tube. Machine B is then started delivering heavy blows to the shank end of the working tool and at the same time rotating the tool. This rotation may be continuous if an independent rotating motor is used as a part of machine B or alternating with the blows if the rotating effect results from mechanism operated by the reciprocations of the piston. As the tool advances into the end of the tube the expanding surfaces 13^c acts as wedges under the hammer blows of machine B and force the interior of the tube outwardly into close contact with the walls of the flue head or sheet C, the rotation of the tool serving to iron out the metal or to produce a rolling effect. Fig. 3 shows the tool advanced to the point where the beading recess 13^e is beginning to flare the outer end of the tube. At this point the imacting action of the process begins, since the heavy blows of the percussive machine are now delivered to the outer

end of the tube as the latter is flared and curled into a bead. This causes the metal of the tube to flow inwardly with a tendency to produce internal swelling of the portion of the tube within the flue head, as is common in all beading processes. However, the holding surfaces 13[d] prevents such swelling of the tube and the flowing metal is tamped, so to speak, or impacted into the metal of the flue head. Fig. 4 illustrates the bead almost completely curled and the expanding surfaces 13[c] extending slightly beyond the inner side of flue head C. The operation of machine B is continued and the impacting effect continues until bead 14[a] is hammered home to the point indicated in Fig. 5, where stops 13[f] engage the flue head. Further operation of machine B causes the blows to be delivered to the flue head and cannot injure the bead or weaken the setting of the tube.

The passing of the expanding surfaces 13[d] beyond the flue head together with the impacting action has expanded the tube behind the inner face of the flue sheet, as indicated at 14[b], so that the flue head is gripped on both its inner and outer surfaces and tightly calked by the inner expansion at 14[b] and by bead 14[a] on the outer face. It is further to be noted that the holding surfaces 13[b] and the contour of the beading recess 13[a] in conjunction with the arresting action of stops 13[f] make the walls of the tube 14 uniform in thickness at and adjacent to the bead 14[a]. The impacting of the metal, as described, insures a tight joint.

Thus the action of the flaring surfaces 13[c] produces the effect of the preliminary interior rolling of the tube in the ordinary hand methods. The flaring and beading of the tube is accomplished by the beading recesses 13[e]. The finishing roll of the ordinary hand methods is entirely obviated by the action of the holding surfaces 13[d] which produce an actual impacting of the metal and a much tighter joint. The finish roll of the tube in the hand-process is for the purpose of tightening the joint, but real impacting of the metal is not secured since percussion is lacking. In addition, the improved process as previously described secures and maintains a uniform thickness of the tube wall, a result which is never accomplished and in fact is quite impossible with the prior hand-processes.

Figs. 7 and 8 illustrate a modified form of tool having surfaces arranged to engage the tube at more than two points in the same transverse plane. The tool disclosed in Figs. 1–6 is ordinarly referred to as a two-bladed tool, while the tool in Figs. 7 and 8 may be called a four-bladed tool. Tool 15 has a reduced entering portion 15[b], expanding surfaces 15[c], holding surfaces 15[d], beading recesses 15[e], stops 15[f], and an extension 15[g] carrying a pilot 15[h] which may be held as in the case of the first tool by a washer 15[i] and rivet head 15[j]. By reason of the greater number of engaging surfaces for the tube the pilot 15[h] may be quite small, or dispensed with entirely, but more satisfactory operation is secured with a large pilot as indicated. The manner of using tool 15 and the effects produced thereby are identical with tool 13.

Figs. 9 to 12 disclose tools for use in the setting of tubes in oil stills. Such stills have an inner apertured head or tube sheet 16 in which the tubes 17 are secured and an outer head 18 in spaced relation to head 16 with hand-holes or openings 18[a] therethrough. While these hand-openings are ordinarily somewhat larger than the tube openings, they are not of sufficient size to permit the use of tools similar to 13 and 15. Tool 19 is similar to tool 13 in that it is of the two-bladed type, but has only one beading projection 19[a]. The still disclosed in Fig. 9 is intended for use with large diameter tubes having thick walls, a half inch or more in thickness. While the present invention contemplates the use of a tool which will expand, flare and bead the tube in one continuous operation, after the process disclosed in Figs. 1 to 5 inclusive, some manufacturers of such stills prefer to give a preliminary rolling of the tube on account of the thickness of the tube wall. Accordingly, tube 17 is shown as having been rolled at 17[a]. Working tool 19 accordingly provides a reduced end 19[b] for easy insertion within the tube, holding surfaces 19[c], flaring surfaces 19[d], and a single beading recess 19[e]. By reason of the thickness of the tube walls there is less flowing of the metal and the holding surfaces 19[c] may accordingly be of a much less extent than those shown for tools 13 and 15. If the tool is to be used for expanding, the holding surfaces will be longer and will have between them and the reduced end 19[b] expanding surfaces of the type shown for tools 13 and 15. Tool 19 has the usual pilot 19[f]. Fig. 9 discloses a ferrule 20 lining the tube opening in flue head 16. Such a ferrule is commonly used when desired in all tube setting work to assist in producing a tight joint. The impacting effect previously described serves to force ferrule 20 into tight engagement with head 16, and the wall of tube 17, in turn, into tight engagement with the ferrule.

Fig. 11 illustrates the manner of setting tubes in a Burton still by the present process. In a Burton still the flue head 21 is a considerable distance from the outer head 22 of the still so that prior manual methods for flue setting are carried on with the greatest difficulty. This arrangement, however, presents no difficulties to the present process since it is only necessary to lengthen the shaft or shank of tool 23 which is shown as arranged for stills of this type. Tool 23 is similar to tool 19 in that it provides only one

beading projection 23^a, but differs from it in having no flaring surface on the opposite side. Tool 23 being utilized for expanding, flaring and beading, has expanding surfaces 23^c adjacent the reduced end 23^b, long holding surfaces 23^d and a single beading recess 23^e of rounded contour similar to those shown in tools 13 and 15. The usual pilot 23^g guides the tool within the tube. The manner of using the tool and the steps of the process are similar in all respects to the disclosure and description relative to Figs. 3 to 5 inclusive, the operation of machine B being continued until the stop projection 23^f engages the flue sheet 21.

With the improved process and apparatus herein disclosed tube or flue setting is no longer a matter of minutes but of seconds. A boiler tube job which requires a crew of three men, much equipment, and several minutes of intense physical effort per tube, can be accomplished by the new process in a small fraction of the time by one man with one tool, and a better, stronger, and much tighter joint is the result. In assembling cracking stills a crew of seven or more men spending twenty minutes and more to a tube can be dispensed with, for one man with a helper does the same work in less than a minute. With the new process skilled labor is not required for the operation is practically automatic, the beading step for example being arrested at exactly the right point so that thinning and weakening of the tube wall at the bead is prevented. The impacting effect produced by directing the blow in an axial direction upon the end of the tube while maintaining the tube wall within the head opening uniform in thickness is of great importance since it makes a very tight as well as a very strong joint.

While the invention has been herein disclosed both as to process and apparatus in what are now considered to be preferred forms, it is to be understood that the invention is not restricted to the specific details thereof but covers all changes, modifications, and adaptations within the scope of the appended claims.

I claim as my invention:

1. The process of securing a tubular member having a thick wall in an apertured head which comprises expanding the member, flaring its outer end, and calking the member to the head by producing a lateral impacting effect within the head aperature, said steps being performed in one continuous operation.

2. The process of securing a tubular member having a thick wall in an apertured head which comprises forming a bead on the end of said member by percussion, and effecting lateral impacting of said member and of said head at said aperture by preventing internal swelling of said member during the percussive action.

3. The process of securing a tubular member having a thick wall in an apertured head which comprises expanding the member, flaring its outer end, and calking the member within the aperture of the head by a lateral impacting effect by supporting the interior of said member by rigid unyielding means, said steps being performed in one continuous operation, and producing a rolling effect upon the interior of said member during said operation.

4. The process of securing the end of a steel tube having a thick wall in an opening in a head while the tube is in a cold state which comprises subjecting the interior of the tube and the end thereof to a combined percussive and rolling effect by means of a rigid unyielding member having a part tightly fitting the interior of the tube so as to expand, flare, bead, and calk the tube in a single continuous operation.

5. That step in the process of securing a tubular member having a thick wall in an apertured head which involves the calking of the member to the head by the lateral impacting of the member into the head within the aperture, said step comprising delivering blows to the end of the member adjacent the aperture and supporting the interior of the member against internal swelling or distortion within the aperture by rigid unyielding means.

6. The combination with a percussive and rotative machine of a tool adapted to be actuated by said machine for securing a tubular member having a thick wall in an apertured head, said tool having means for expanding that portion of the member within the aperture of said head, means for flaring and beading the end of said member, and means for fixing and maintaining the thickness of the wall of said member at and adjacent to the beaded portion thereof.

7. The combination with a percussive and rotative machine of a tool adapted to be actuated by said machine for securing a thick-walled tubular member in an apertured head, said tool having means for imparting the blows of the machine to the end of said member and means for rigidly holding said member against internal expansion in the plane of said head.

8. The combination with a percussive and rotative machine of a tool for setting a thick-walled tube in an apertured head, said tool having a pilot loosely fitting the interior of the tube, and a blade rearwardly of said pilot having an expanding surface, a holding surface, and a beading recess successively acting upon said tube as the tool is advanced.

9. The combination with a percussive and rotative machine of a tool for setting a tube in an apertured head, said tool having a pilot loosely fitting the interior of the tube, and blades rearwardly of said pilot presenting an-

gularly inclined radially disposed surfaces for expanding the interior of the tube, at least one of said blades having surfaces for turning a bead upon the end of the tube, said blades having holding surfaces for rigidly maintaining the thickness of the wall of the tube within the head substantially uniform during the beading operation.

10. The combination with a percussive and rotative machine of a tool for setting a thick-walled tube in an apertured head, said tool having a plurality of longitudinally disposed radially extending blades having inclined surfaces for expanding the interior of the tube, and holding surfaces for rigidly maintaining the wall of the tube substantially uniform within the head, at least one of said blades having surfaces for turning a bead upon the end of the tube.

11. A metal working tool for setting thick-walled tubular members having a shank arranged to receive blows and means at the opposite end for beading a tubular member in a head and for calking the member in the head with a lateral impacting effect.

12. A tool for setting thick-walled tubes in boilers, stills, and the like, having a shank to receive rotative and percussive impulses, a pilot at the opposite end to enter a tube and blades rearwardly of said pilot having surfaces for expanding, flaring and beading the tube and for holding the tube against internal distortion during the beading operation thereby to produce a lateral impacting effect and a calked joint.

Signed by me at New York, in the county of New York and State of New York, this 31st day of July, 1926.

ADOLPH C. ANDRESEN.