Nov. 20, 1945. E. L. McKINNEY ET AL 2,389,206

APPARATUS FOR GAUGING AND STRAIGHTENING

Filed Dec. 13, 1943 4 Sheets-Sheet 1

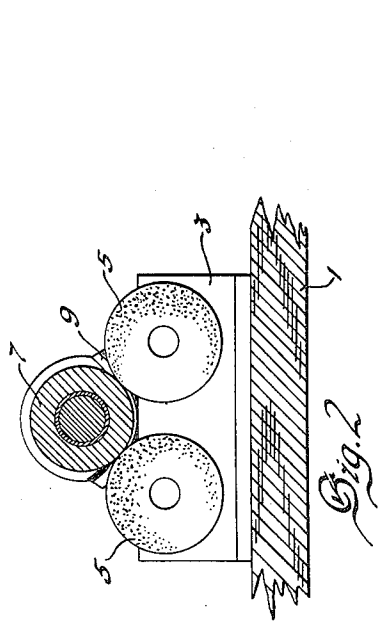


Fig. 2

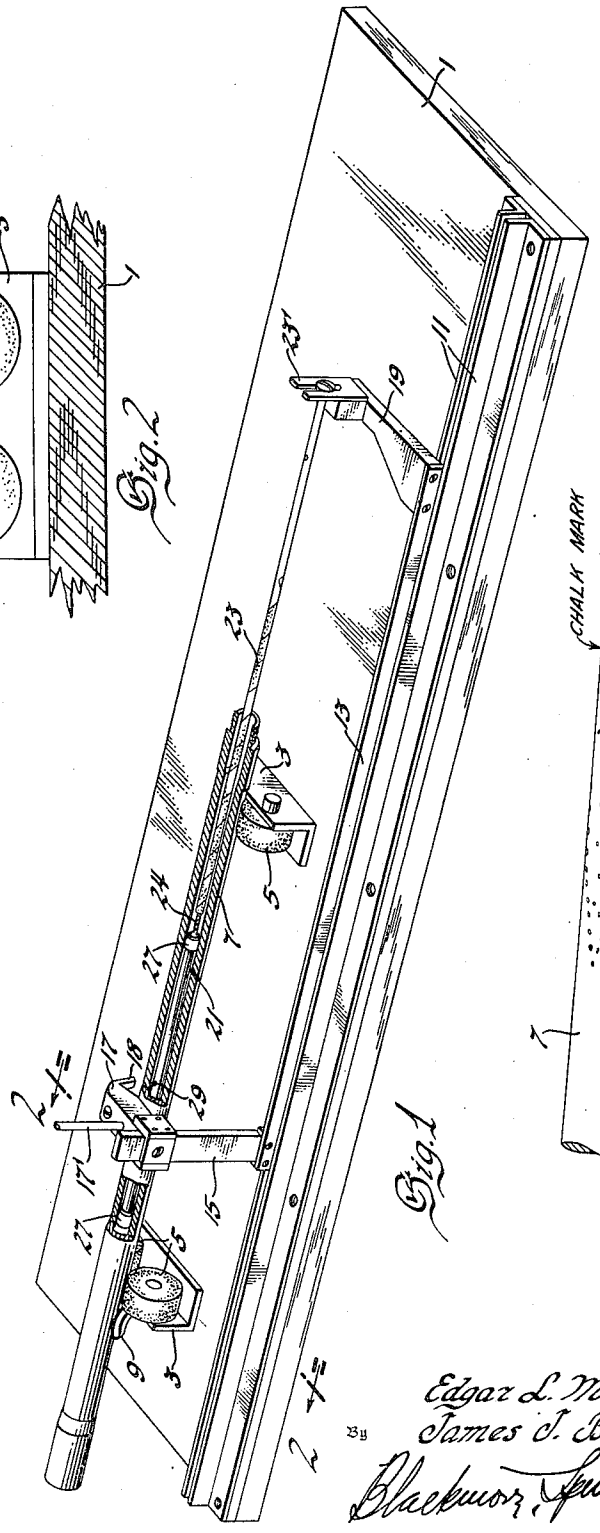


Fig. 1

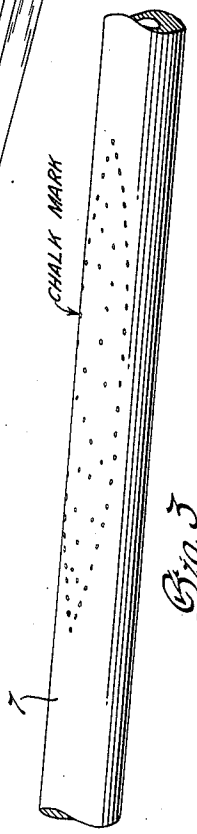


Fig. 3

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APPARATUS FOR GAUGING AND STRAIGHTENING

Filed Dec. 13, 1943 4 Sheets-Sheet 2

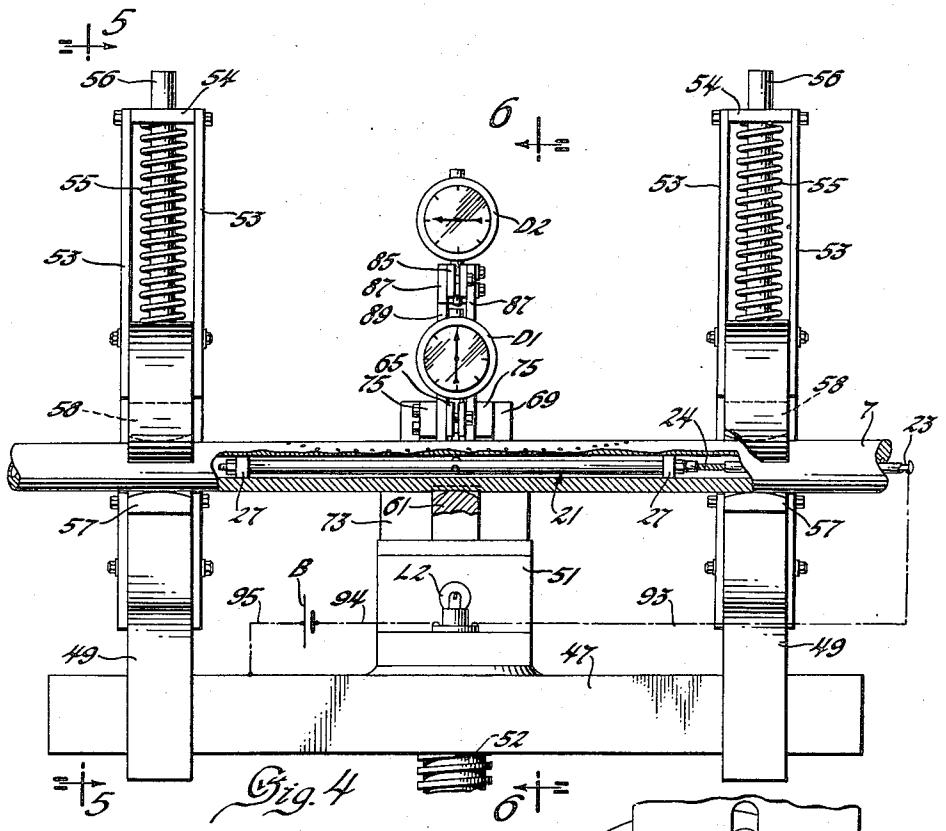


Fig. 4

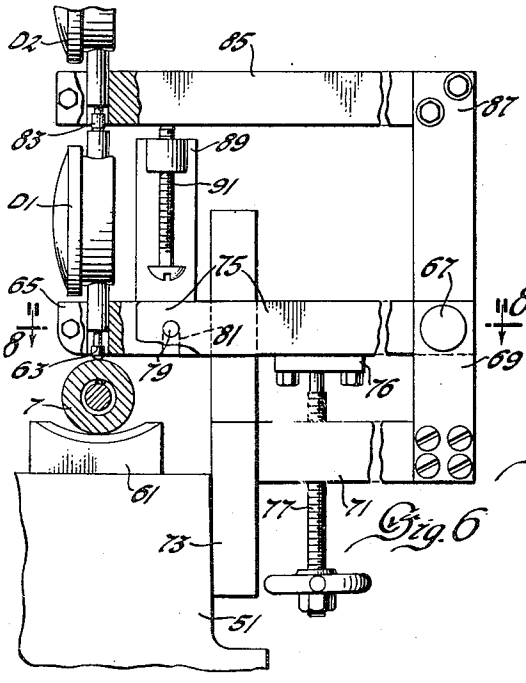


Fig. 6

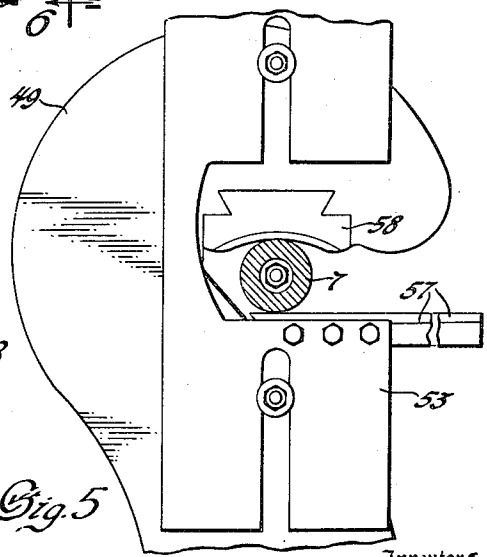


Fig. 5

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APPARATUS FOR GAUGING AND STRAIGHTENING

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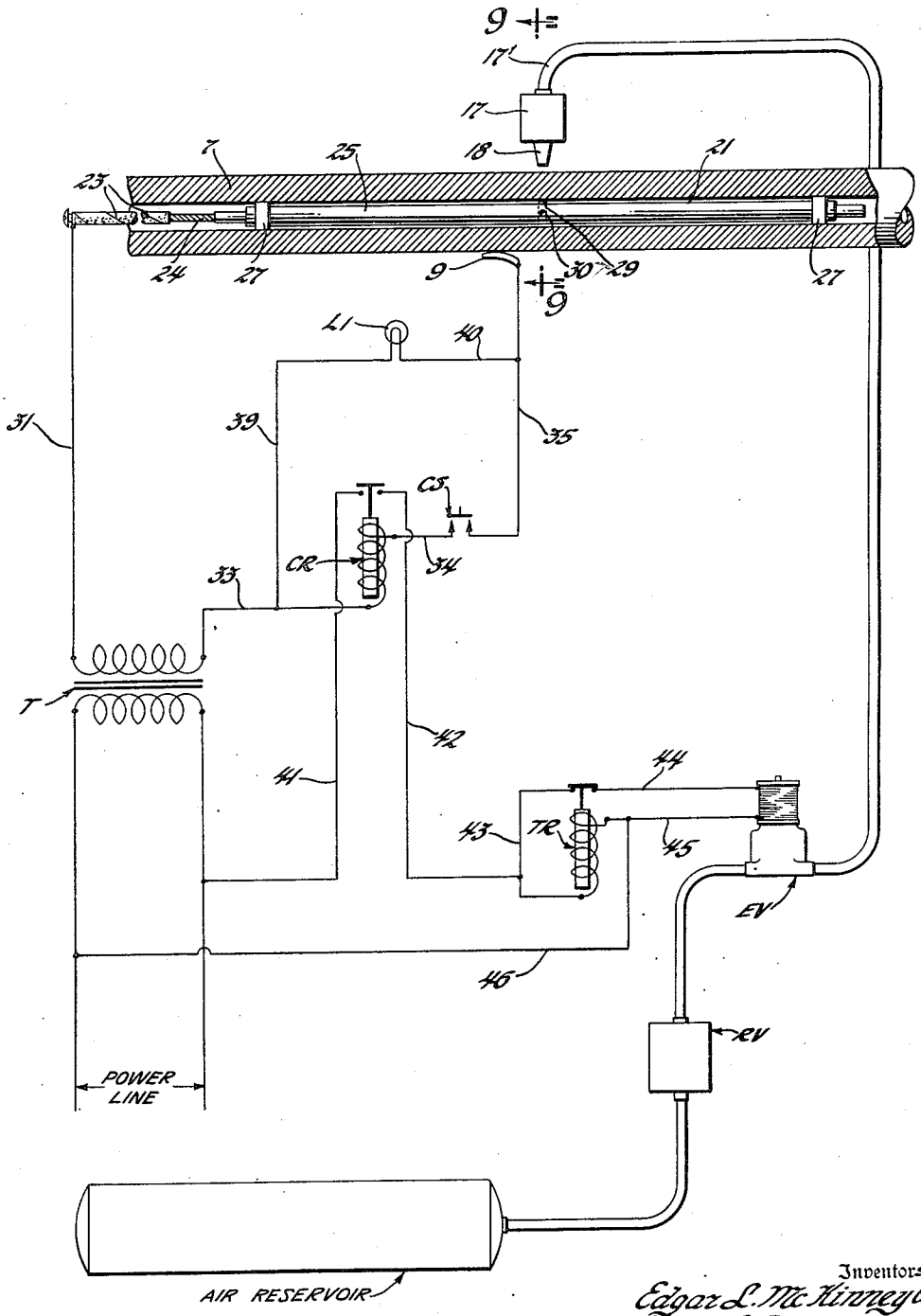


Fig. 7

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APPARATUS FOR GAUGING AND STRAIGHTENING

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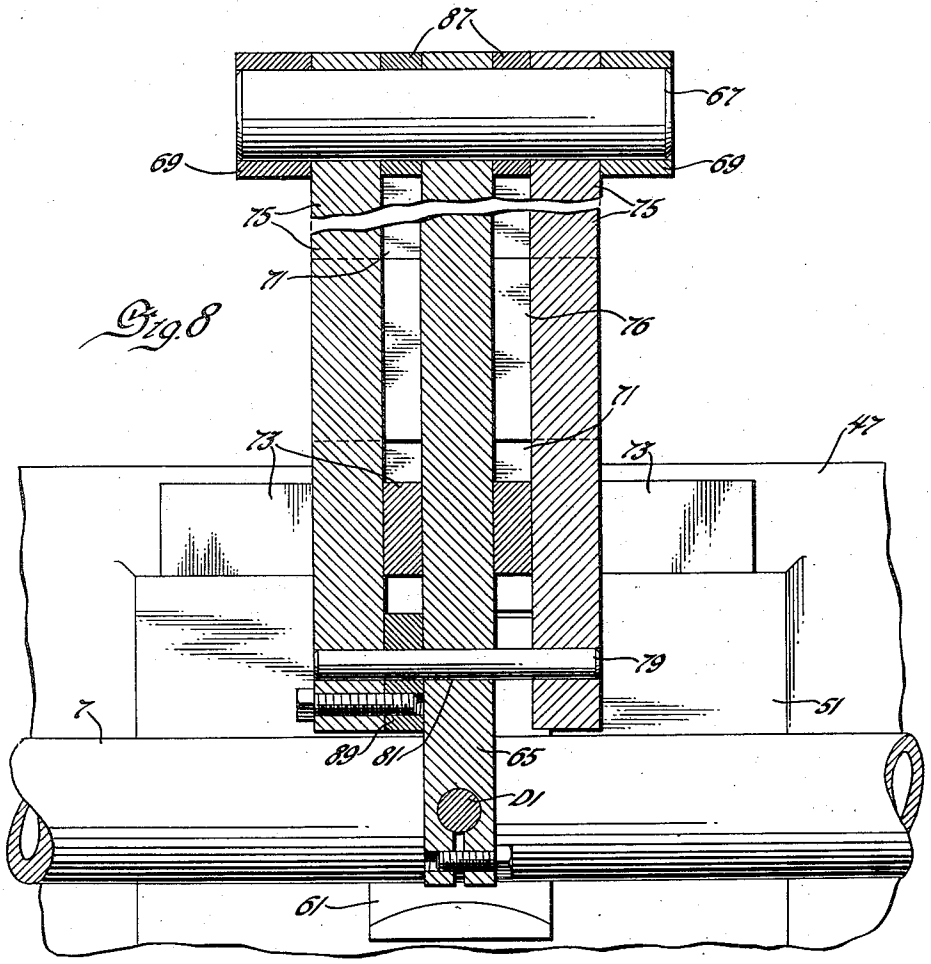


Fig. 8

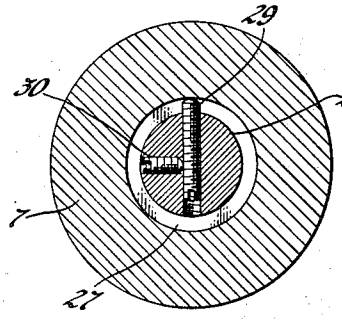


Fig. 9

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UNITED STATES PATENT OFFICE

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APPARATUS FOR GAUGING AND STRAIGHTENING

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Application December 13, 1943, Serial No. 514,026

4 Claims. (Cl. 153—32)

The present invention generally relates to apparatus for gauging deviations from straightness and correcting such deviations in tubes and more particularly for gun barrel tubes.

One object of the invention is to provide precision gauging means for the bores of gun barrels and marking means controlled thereby for marking the barrels where slight deviations from straightness are present.

Another object is to provide straightening means including indicating means controlled by the gauging means and separate measuring and indicating means for determining the amount of these deviations and the extent of reverse bending required at the points of deviation marked to eliminate these deviations.

Figure 1 of the drawings is a perspective view of gauging and marking apparatus.

Figure 2 is an enlarged cross sectional view taken on line 2—2 of Figure 1.

Figure 3 is an enlarged view of a portion of a gun barrel showing the marking left on the gun barrel by the gauging and marking apparatus.

Figure 4 is a front elevation of the straightening and indicating apparatus.

Figure 5 is an enlarged view taken on line 5—5 of Figure 4 with parts broken away to show details of one of the barrel supporting members.

Figure 6 is an enlarged view taken on line 6—6 of Figure 4 to show details of the indicating apparatus.

Figure 7 is a diagrammatic view of the control connections between the gauging and marking apparatus shown in Figure 1.

Figure 8 is an enlarged sectional view taken on line 8—8 of Figure 6, and

Figure 9 is an enlarged sectional view taken on line 9—9 of Figure 7.

As shown in Figure 1 the gauging and marking apparatus comprises a base 1, two roller supports 3 secured at longitudinally spaced points on the base and a pair of non-conducting rollers 5, mounted for rotation about parallel axes on each of the roller supports 3 for permitting rotation of a gun barrel 7 about its longitudinal axis. One roller support is provided with flexible electrical contacts 9 which bear lightly on the exterior surface of the gun barrel. Longitudinal guides 11 are secured to the base 1 to guide a longitudinal carriage member 13 to which are secured a vertical arm 15 for supporting a pneumatic marking device 17, and a horizontal arm 19 to which is connected an electrical plug gauge 21 so that the marking device 17 is moved along the exterior of the gun barrel and the plug gauge 21 is moved through the bore of the barrel when the carriage is moved with respect to the guides 11.

The electrical plug gauge, as best shown in Figures 7 and 9, includes a handle comprising an insulated conductor rod 23 and flexible cable 24 which are electrically connected to one end of the plug gauge contact rod 25 on which two insulated bushings of hardened steel 27 are secured at longitudinally spaced points on the rod 25. A contact screw 29 is threaded in a diametrical opening in the rod midway between the bushings and locked therein by a set screw 30. The diameter of the bushings 27 is .4992 of an inch for insertion into the bores of a 50 caliber gun barrel, the diameters of which vary between .4995 and .5010 of an inch and the distance between the bushings is twenty-four times the diameter of the bushings or one foot. The contact screw 29 is adjusted so that one end, which is rounded, projects radially outwardly from the contact rod in order to contact the bores of gun barrels which vary .0005 to .002 from being straight for each foot of bore length when the gauge is moved through the bore of the barrels. With bushings and contact screw arranged in this manner, the rounded end of the screw will accordingly contact the surface of the bore at the inside of a slight bend of the barrel. The outer end of the insulated conductor rod 23 of the plug gauge handle is electrically connected to a slotted connector 23' secured to and electrically insulated from the end of the horizontal arm 19 of the carriage.

The marking device 17 is secured on the arm 15 of the carriage and includes a compartment containing powdered chalk, and provided with and air pressure inlet connection 17' and an outlet nozzle having an opening for directing the chalk radially with respect to the gun barrel and directly toward the rounded end of the contact screw 29 of the plug gauge 21 when air pressure is applied to the inlet connection 17'. Pneumatic and electrical means, shown best in Figure 7, are provided for causing chalk to be deposited on the exterior surface of the gun barrel adjacent to the point of contact of the contact screw 29 of the plug gauge 21 with the bent portion of the bore of a gun barrel.

The pneumatic means comprise a well known type of reducing valve RV and an electropneumatic valve EV connected in series relation between the pressure inlet opening 17' of the marking device 17 and a pressure reservoir by means of suitable pipe and flexible hose connections to permit movement of the marking device along the barrel 7.

Electrical control means are provided for controlling energization of the electropneumatic valve EV when the contact screw 29 of the gauge contacts the bore of the gun barrel in order to cause the valve to open momentarily thereby causing a spurt of powdered chalk to be deposited on the barrel. The electrical means includes a manually operable control switch CS, a control relay CR and timing relay TR, each of conventional type, and also an electrical indicator lamp L1 electrically connected between a power source and the electrical plug gauge 21 in the following manner:

The connector 23', to which the outer end of the conductor rod 23 of the plug gauge is electrically connected is connected by a flexible conductor 31 to one terminal of the secondary of a transformer T, the primary terminals of which are connected between the conductors of a power line. The winding of the control relay CR and the manually operable control switch CS are connected in series between the other transformer secondary terminal and the flexible electrical contacts 9 bearing on the gun barrel by conductors 33, 34 and 35, and the indicator lamp L1 is connected in shunt relation with the relay winding and switch CS by conductors 39 and 40. The normally open pair of stationary contacts of the control relay CR, which are bridged by the movable relay armature upon energization of the relay winding, are connected in series between one power line conductor and one winding terminal and one of the normally closed pair of stationary contacts of the timing relay TR by conductors 41, 42 and 43. The other stationary contact of the timing relay is connected by a conductor 44 to one winding terminal of the electropneumatic valve EV, the other winding terminal of which is connected by conductors 45 and 46 to the other terminal of the winding of the timing relay and the other power conductor. It will be evident from the above described connections that the winding of the electropneumatic valve EV is connected in shunt relation with the winding of the timing relay TR through the normally closed contacts of the relay TR.

With the above described electrical power and control connections, when the contact screw 29 of the electrical plug gauge contacts the bore of a bent gun barrel the transformer secondary circuit is completed through the gun barrel 7, the closed control switch CS, the winding of the control relay CR and conductors 31, 33, 34 and 35, and the shunt circuit through the indicator lamp L1 comprising conductors 39 and 40 is also completed to cause illumination of the lamp. Energization of the winding of the control relay causes the relay armature to bridge the relay stationary contacts and complete an energizing circuit through the winding of the timing relay TR and the winding of the electropneumatic valve and conductors 41 to 46. Energization of the winding of the electropneumatic valve causes the valve to open, and simultaneous energization of the winding of the relay TR causes the relay armature to start moving out of contact with the fixed relay contacts. The winding of the electropneumatic valve is accordingly energized momentarily or only until the armature of the relay TR moves out of contact with the relay contacts. This momentary opening of the valve EV causes a spurt of air through the tube 17' into the marking device 17 where powdered chalk is picked up by the air stream and carried through the nozzle 18 of the marking device onto the gun barrel to clearly mark the exact location of a bend in the barrel at the inside of the bend therein.

A straightening device, best shown in Figure 4, is provided for readily straightening the bent gun barrels marked by the above described apparatus. This device includes a horizontal base bar 47, a pair of vertical gun barrel supporting bars 49 mounted for horizontal sliding movement thereon, and a jack screw block 51 secured to the base bar 47 between the supporting bars in which a vertical jack screw 52 is threaded. The upper ends of the supporting bars 49 are of C shape, as best shown in Figure 5, and clamping plates 53 are mounted for vertical sliding movement on each side of the bars 49. The upper ends of the clamping plates 53 are connected by a plate 54, as best shown in Figure 4. A compression spring 55 is placed between each of the plates 54 and the upper extremity of each of the upper C shaped ends of the bars 49 to urge the clamping bars upwardly. The springs 55 are placed on spring posts 56 secured at their lower ends to the bars 49 and extend upwardly through suitable openings in the plates 54. The lower ends of each of the clamping plates 53 are connected by an anvil plate 57 which projects horizontally therebetween and is provided with a curved upper surface, as best shown in Figures 4 and 5, so that a gun barrel may be placed between the anvil plates 57 and when pressed downwardly the anvils and clamping plates may be moved downwardly to permit the barrel to be easily moved into the C shaped upper portions of the supporting bars 49. When the downward pressure on the barrel is released the springs 55 accordingly urge the clamping plates 53, anvils 57 thereon and the gun barrel upwardly into point contact with the lower curved surface of each of the curved anvil plates 58 secured in the upper portion of each of the C shaped ends of the bars 49, as best shown in Figures 4 and 5. The upper end of the jack screw is also provided with an anvil 61 having a curved upper surface for upward movement into point contact with the gun barrel between the ends thereof and in axial alignment with the points of contact between the ends of the barrel and the anvils 58 of the bars 49.

Dial indicators D1 and D2 are movably supported on the jack screw block 51 to permit insertion of a gun barrel into the C shaped bars 49 in the above described manner, and an electrical indicator lamp L2 is also mounted on the block 51, as best shown in Figure 4. The electrical indicator lamp L2 which is controlled by an electrical plug gauge 21 identical to the one previously described and the dial indicators D1 and D2 provide the means for determining the extent the gun barrels are bent at the points marked by chalk and also to what extent they must be bent in the reverse direction by the jack screw 52 to get them to take a permanent set with the bores therein straight within .0005 to .002 of an inch per foot of bore length.

As best shown in Figures 6 and 8 the lower dial indicator D1 is provided with an operating plunger 63 which is capable of moving upwards .010 of an inch with respect to the case of the indicator after which the whole indicator is forced up. The dial of this indicator is graduated in divisions of .0001 of an inch and the case is clamped to one end of a supporting arm 65 which is pivotally mounted on a horizontal pivot pin 67 secured on a stationary bracket comprising members 69, 71 and 73 which are rigidly secured to the jack screw block 51, as best shown in Figures

6 and 8, so that the axis plunger 63 of the dial indicator D1 is normally in coaxial relation with the jack screw when the indicator supporting arm 65 is horizontal, as shown in Figures 4 and 6. In order to move the supporting arm 65 for the indicator D1 angularly about the pivot pin 67 so that the gun barrel may be inserted in the straightening device without touching the plunger 63 of the indicator, two adjusting arms 75 are pivoted at one end on the pivot pin 67 either side of the supporting arm 65 and are connected intermediate the ends thereof by means of a strut 76 secured to the lower edges of the adjusting arms. The strut 76 rests on a vertical adjusting screw 77 threaded in the stationary bracket member 71. The other ends of the adjusting arms 75 are connected by a pin 79 secured thereto which extends through a slot 81 in the lower edge of the indicator supporting arm 65. The supporting arm 65 accordingly is supported by the pin 79 of the adjusting arms 75 and the outer end of the indicator supporting arm 65 may accordingly be moved upwardly away from the anvil 61 of the jack screw 52 to permit insertion of a gun barrel or moved downwardly so that the lower end of indicator plunger 63 contacts the gun barrel in order to set the indicator pointer to zero reading by rotation of the adjusting screw 77.

The dial indicator D2 is provided with a plunger 83 which is capable of moving .200 of an inch and the dial is graduated in divisions of .001 of an inch. The case of this indicator is clamped to the outer end of a horizontal member 85 of a movable bracket and the inner end of the member 85 is rigidly secured to the upper end of a vertical bracket member 87 which is pivotally mounted at its lower end on the pivot pin 67 so that the plunger 83 of the indicator is normally held in coaxial relation with that of the axis of the plunger 63 of the lower indicator and rests on the upper portion of the case thereof, as best shown in Figures 4 and 6. The bracket supporting the upper indicator is adjustably supported above the supporting arm 65 of the lower indicator by means of a member 89 secured on one of the adjusting arms 75, as best shown in Figure 8. The member 89 has a vertical adjusting screw 91 threaded therein, the upper end of which is in contact with the bracket member 85 of the dial indicator D2. It will be evident that the adjusting screw 91 may be rotated to bring the plunger 83 of the dial indicator D2 into contact with the case of the lower dial indicator and adjust its reading to zero and that when the lower adjusting screw is rotated to move the lower indicator D1 upwardly the upper indicator D2 will also be moved upwardly by the member 89 and screw 91 mounted thereon as the upper end of the screw is in contact with the bracket member 85 on which the dial indicator D2 is clamped.

The indicator light L2 is shown in dash and dotted lines connected by conductors 93, 94 and 95 in series circuit relation with a battery B between the base bar 47 and the conductor rod 23 of the electrical plug gauge 21 shown in Figure 4 inserted in a bore of a gun barrel 7 with the rounded end of the contact screw 29 of the gauge extending vertically upward and in coaxial relation with the plungers of the dial indicators D1 and D2. With the light L2 connected in this manner, when the contact screw 29 of the gauge contacts the surface of the bore of a barrel which is bent, the light will be illuminated.

With the ends of a bent gun barrel supported in line contact with the anvil blocks 58 of the barrel supporting bars 49 by means of the spring urged clamping members 53 and the curved anvils 57 thereon in the manner previously described, the straightening operation on the gun barrel is performed in the following manner:

The center of the chalk mark on the inside of the bend in the barrel is moved directly under the plunger of the lower dial indicator D1. The outside of the bend in the barrel will accordingly be directly over the center of the curved surface of the anvil 61 of the jack screw 52. The electrical plug gauge 21 is then inserted in the bore of the barrel with the end of the contact screw 29 extending vertically upward and in contact with the surface of the bore in the barrel at a point directly under the plunger 63 of the lower dial indicator D1 which completes a circuit to the indicator light L2 to cause illumination thereof. The adjusting screw 77 is then adjusted to set the lower dial indicator D1 to zero reading and the other adjusting screw 91 is also adjusted to set the upper dial indicator D2 to .010. The jack screw 52 is then rotated to apply upward bending force on the gun barrel necessary to move the contact screw 27 of the gauge out of contact with the bore of the barrel which causes the light L2 to go out which indicates that the barrel is straight. The reading of the lower indicator then indicates the amount the barrel is bent. The plug gauge 21 is then rotated to make sure that the contact screw 29 of the gauge does not come in contact with the bore of the barrel at other points which would cause the light L2 to be illuminated. If no contact of the screw 29 takes place, the plug gauge 21 is removed and the jack screw 52 is turned to cause further upward movement of a distance of .050 of an inch as read on the indicator D2 to give the barrel a further reverse bend and the jack screw is then moved downwardly out of contact with the barrel and the reading of the lower indicator D1 again noted. If this reading is less than the indication just necessary to straighten the barrel it must be deflected upwardly successively greater amounts until the barrel takes the permanent set necessary to cause the indicator D1 to indicate the same reading as that originally indicated to cause the indicator light to go out which indicates that the bore of the barrel is straight within .0005 to .002 of an inch per foot of bore length.

The above gauging and straightening apparatus and method of using the apparatus enables bent gun barrels to be easily and quickly straightened in the manner described.

We claim:

1. Apparatus for gauging and straightening bent tubes comprising means for supporting a tube at points intermediate the ends thereof, means for applying bending force at bent points in the tube intermediate the points of support, an electrical plug gauge having insulating guiding portions insertable in the tube and an electrical contact between the guiding portions adapted to contact with the interior of the tube only at the bent points therein, an indicator controlled by said gauge, electrical control connections between said tube, said plug contact and said indicator to control operation of the indicator upon contact between the plug contact and tube, and means contactable with the exterior of the tube at the bent points in the tube opposite the point at which the bending force is applied for measuring the deflection necessary to render the indicator inoperative and the tube straight.

2. Apparatus for gauging and marking devia-

tions from straightness of tubes comprising an electrical plug gauge having insulating guides secured thereto in coaxial relation adapted to be moved through the tube and an electrical control contact on said plug gauge located midway between the guides for electrical contact with a bent portion of the interior surface of the tube, electrically controlled marking means and means for electrically and mechanically connecting said marking means to the plug gauge for control thereby and movement therewith along the outer surface of the tube adjacent to the contact of the plug gauge to cause the exterior of the tube to be marked at the bent points therein.

3. Apparatus for gauging and marking portions of tubes deviating from straightness comprising an electrical plug gauge having a pair of insulating bushings secured thereto in axial alignment and adapted to be guided in and moved axially through a rotating tube and an electrical contact adjustably secured to the gauge midway between the insulating bushings and adapted to contact the interior of the tube at the inside bends in the tube of known amount, electropneumatically marking means mounted for movement along the exterior of the tube for marking the external surface of the tube with powder and combined mechanical and electrical control connections between said plug gauge contact, said tube and said marking means for causing movement of the marking means along the tube and movement of the plug gauge through the tube adjacent the marking means and for also causing operation of said marking means at the inside of each of the bends in the tube.

4. Apparatus for gauging and marking deviations from straightness of tubes comprising means for supporting a tube for rotation about its axis, means movable parallel to the tube axis, an electrical plug gauge and electropneumatic marking means operatively connected to and movable by said movable means to cause said gauge to move longitudinally through said tube and to cause said marking means to be moved along the exterior of said tube adjacent said gauge, said electropneumatic marking means comprising a powder container having an outlet nozzle directed radially toward the tube and an air pressure supply pipe including an electropneumatic valve, said electrical gauge comprising a contact rod, insulating bushings secured thereto at spaced points on said rod and of slightly less diameter than the opening in said tube and an electrical contact mounted on said rod for radial adjustment between the bushings for contact with the interior of said tube at a bent portion therein directly opposite the outlet nozzle of said marking means and electrical control connections including a timing relay connected between said tube, said contact rod and said electropneumatic valve to cause a spurt of air and powder to be deposited on said tube at a point directly opposite the point of contact between the contact on the gauge and tube.

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