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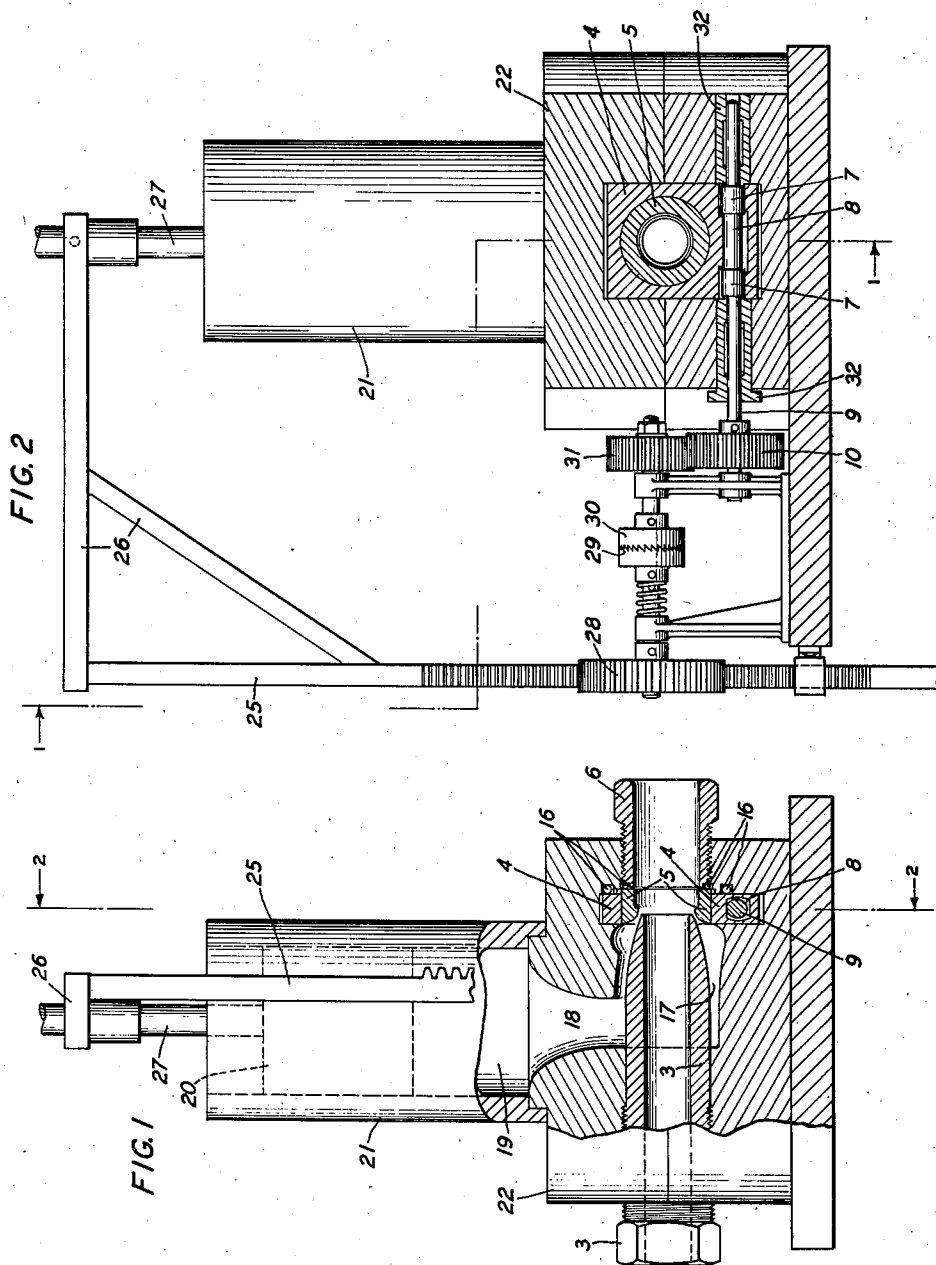
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2,131,173

CABLE SHEATH EXTRUDING PRESS

Filed Feb. 15, 1936

4 Sheets-Sheet 1



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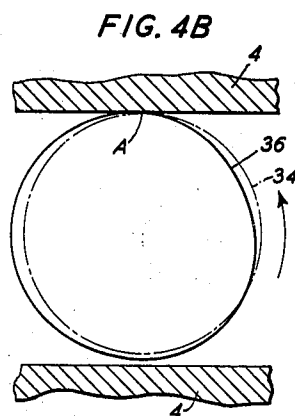
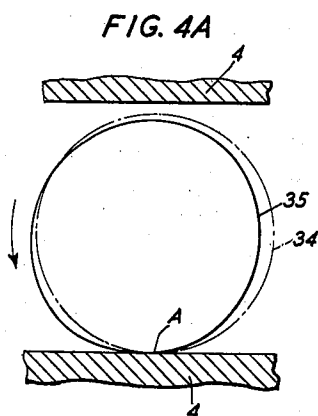
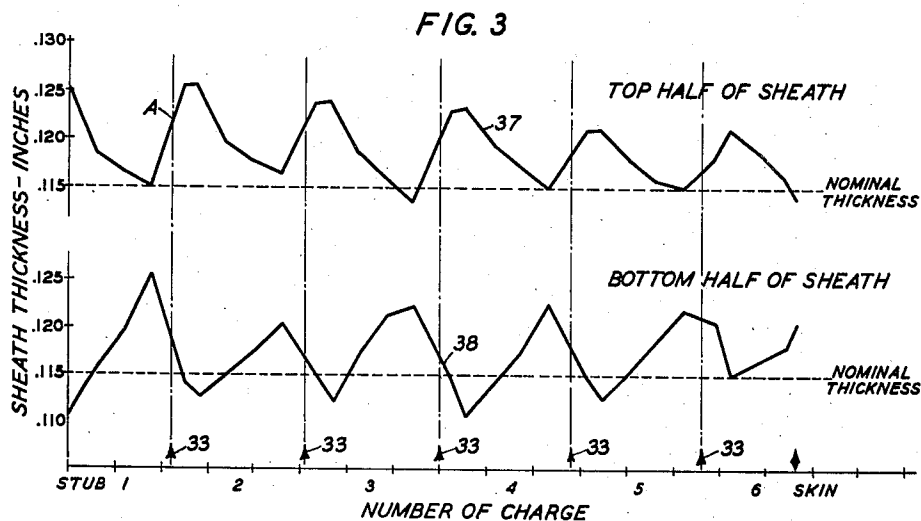
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CABLE SHEATH EXTRUDING PRESS

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4 Sheets-Sheet 2



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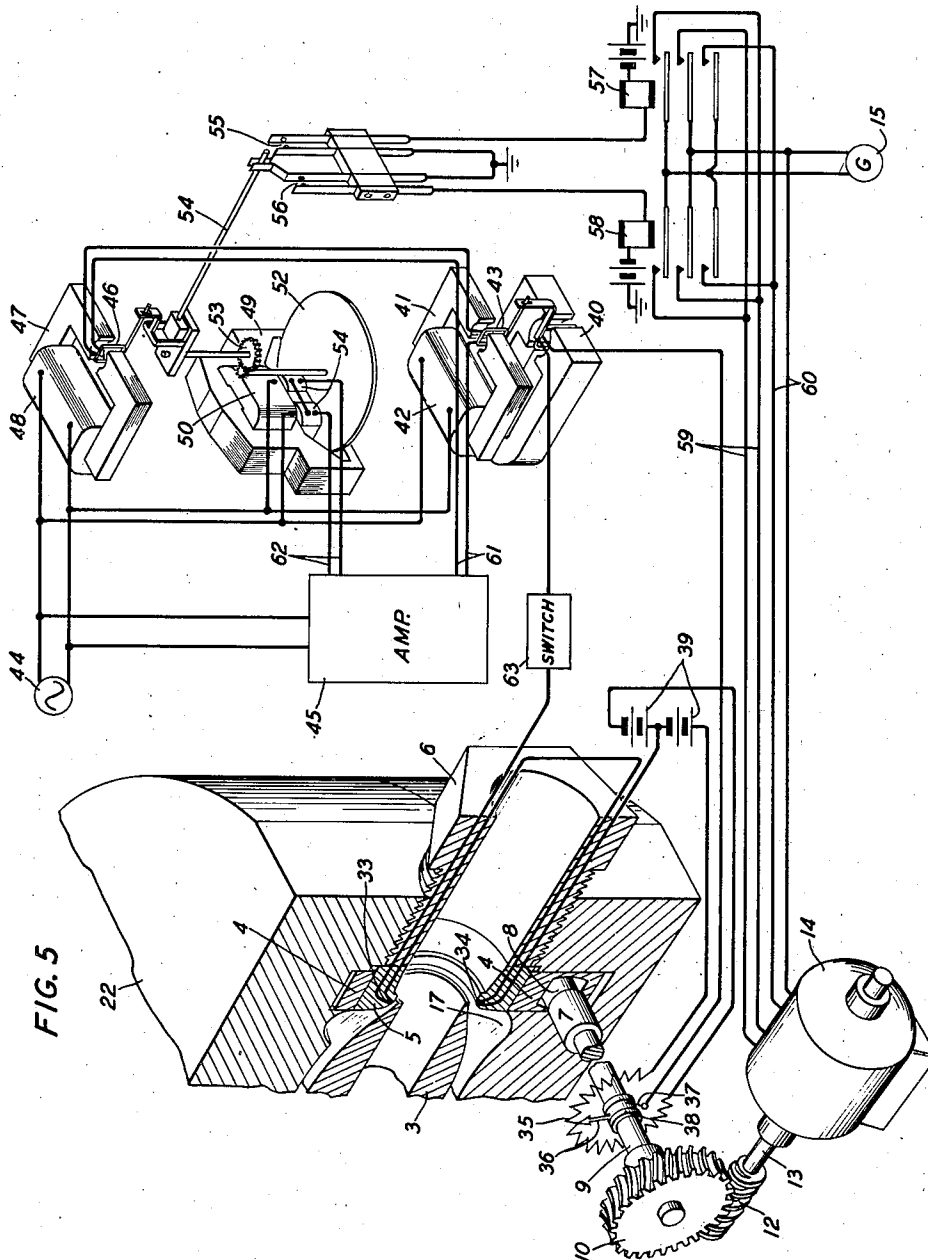
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CABLE SHEATH EXTRUDING PRESS

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4 Sheets-Sheet 3



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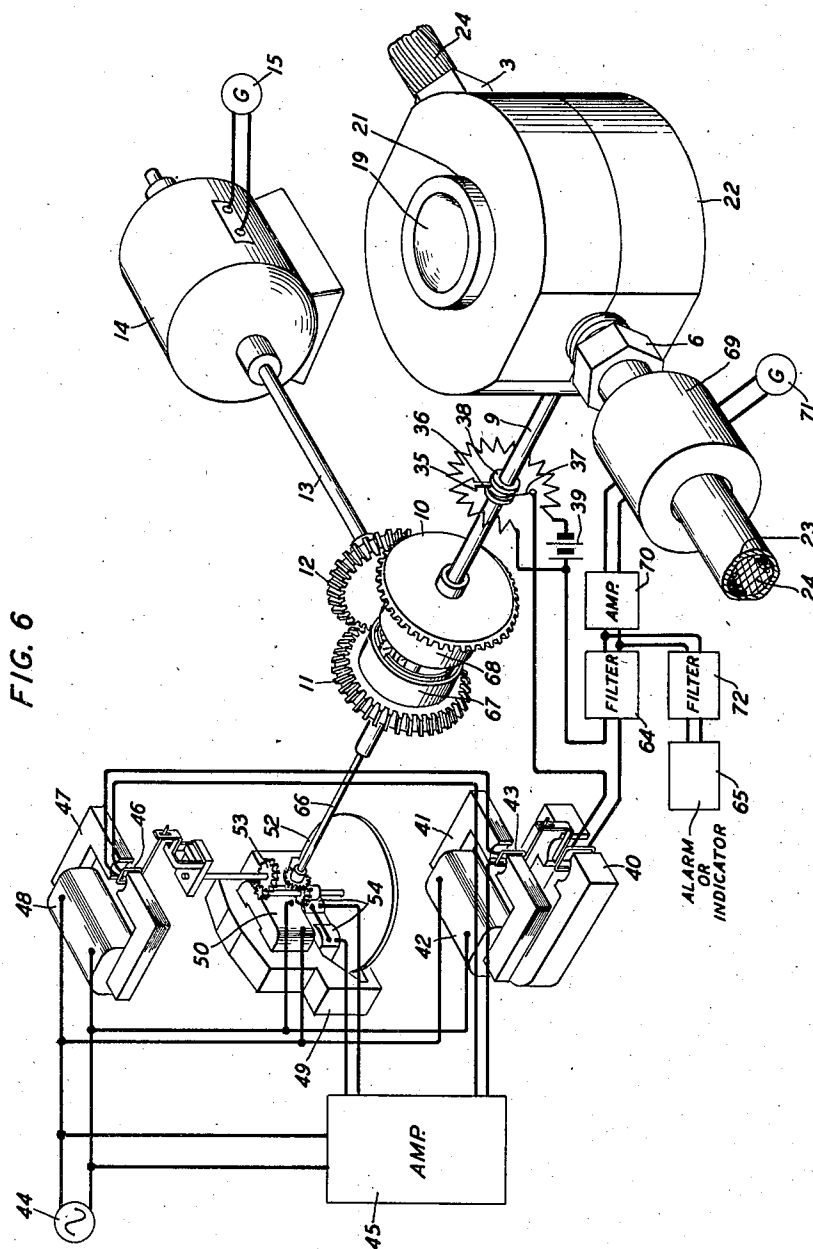
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CABLE SHEATH EXTRUDING PRESS

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4 Sheets-Sheet 4



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UNITED STATES PATENT OFFICE

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CABLE SHEATH EXTRUDING PRESS

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Application February 15, 1936, Serial No. 63,997

13 Claims. (Cl. 207—4)

This invention relates to the extrusion of plastic and semi-plastic materials and more particularly to the extrusion of sheaths such as lead cable sheath.

5 The thickness of lead cable sheaths has been found to vary considerably in a number of different manners. Consequently, in order to insure a given amount of protection or minimum thickness of the sheath it has heretofore been
10 necessary to increase the average thickness considerably. This makes the cable more expensive to construct and also heavier and therefore more expensive to transport and install and necessitates a more substantial and stronger supporting
15 structure.

One of the major variations of the thickness of the lead sheath has been found to be due to the eccentricity of the cable sheath with respect to the cable which it encloses.

20 An object of this invention is to reduce eccentricity of cable sheath and variations in its thickness.

The sheath undergoes cyclic variation throughout the extruding cycle. Therefore, in accordance with one embodiment of this invention the
25 relative positions of the core tube and the sizing or extruding die are varied in accordance with the extruding cycle. The extruding cycle as referred to herein means the cycle of operations of the extruding press which comprises, charging, extruding, return and again charging, and so forth.

The eccentricity of the cable sheath also varies in accordance with the difference in temperature of different parts of the extruding apparatus.

35 The temperature difference of different parts of the extruding or sizing die has been found to vary substantially as the eccentricity of the cable sheath. Consequently, in accordance with another embodiment of this invention the relative
40 positions of the core tube and sizing die are controlled by the temperature difference of different parts of the sizing die.

In still another embodiment of this invention the electrical properties, such as resistivity, of different portions of the sheath are continuously
45 measured as the cable is extruded. The measuring apparatus is operatively connected to the extrusion press to control the relative positions of the sizing die and core tube in the extrusion
50 chamber of the extrusion press whereby variations in the eccentricity of the cable sheath with respect to the cable core are substantially eliminated.

Various other objects and features of this invention relate to the electrical measuring devices for measuring various factors relating to the eccentricity of the cable sheath in combination with electrical amplifiers and indicating devices as well as to the mechanical arrangement including
60 mechanical amplifiers for controlling the rela-

tive positions of the core tube and sizing die in accordance with the various factors related to the eccentricity of the cable sheath.

The various objects and features of the invention may be more readily understood from
5 the following description of several specific embodiments thereof, and the novel features are specifically pointed out in the appended claims. The following description may be more readily
10 understood by reference to the attached drawings in which:

Figs. 1 and 2 show one embodiment of this invention in which the position of the sizing die relative to the core tube is controlled by an operative connection to the ram or piston of the
15 extrusion press;

Fig. 3 shows typical curves of the variations in the thickness of the top and bottom portions of the sheath with respect to the extrusion cycle;

Figs. 4—A and 4—B illustrate in diagrammatic
20 form the corresponding shapes of the cams for controlling the relative positions of the core tube and sizing die;

Fig. 5 shows in diagrammatic form an arrangement for controlling the relative positions of the
25 sizing die and the core tube in accordance with the difference in temperature of different portions of the sizing die; and

Fig. 6 shows in schematic form an arrangement for continuously measuring the thickness of
30 the cable sheath and for controlling the relative positions of the sizing die and core tube in accordance with the measurements which it makes.

Corresponding parts of the various figures have been designated by the same numerals.

Referring more particularly to Figs. 1, 2, 3 and 4, Fig. 1 is a side view and partial sectional view along lines 1—1 of Fig. 2, showing a lead press to which the invention is applied. Fig. 2 shows a front and partial sectional view along lines
40 2—2 of Fig. 1 in diagrammatic form. Referring to Fig. 1 the cable core enters the extrusion chamber 17 in extrusion block 22 through core tube 3 which is supported in the extrusion block
45 22. Core tube 3 extends through the extrusion block 22 to the far end of the extrusion chamber 17 near the sizing die 5. The extrusion chamber 17 is connected by channel 18 to cylinder 19. An extrusion ram or piston 20 enters cylinder or
50 chamber 19 and forces the sheath material out through channel 18 into extrusion chamber 17 where the material passes between the tip of the core tube 3 and the sizing die 5 and surrounds the core as the core passes through core tube 3, extruding chamber 17 and out of the extrusion
55 press through the sizing die holder 6.

In the usual extrusion press for extruding lead cable sheaths the relative positions of the sizing die 5 and core tube 3 remain fixed during the extrusion of the sheath. In a press of this type 60

it has been found that the thickness of the lead or other sheath material on the top half of the cable varies oppositely from the thickness of the sheath on the bottom half of the cable and that these thicknesses vary cyclically during the extrusion cycle. These variations are clearly shown by the typical curves shown in Fig. 3 in which curve 37 shows the variation of the thickness of the top half of a cable sheath during the extrusion cycles while curve 38 shows the corresponding variation in thickness of the bottom half of the cable sheath. It is to be noted that as the top half of the cable becomes thinner the bottom half becomes thicker and vice versa. This clearly indicates that the cable sheath is eccentric. It is further to be noted that the thickness changes most rapidly near the ends of the extrusion cycles that is during the portions of the extruding cycle just before and after the extrusion chamber has been recharged. The ends of the extrusion cycles are indicated in Fig. 3 by arrows 33. In accordance with the embodiment of this invention shown in Figs. 1 and 2 the relative positions of the sizing die 5 and core tube 3 are altered in such a way as to counteract this cyclic variation in the thickness or eccentricity of the cable sheath. In accordance with this invention, the sizing die is raised relative to the core tube during the portion of the cycle in which the top of the cable sheath normally becomes thinner, thus tending to decrease the thickness of the sheath on the bottom of the cable and increase it on the top.

One possible explanation for this cyclic variation of the thickness of the cable sheath is that the relative temperatures of the extruding material on the top and bottom of the extruding chamber around the sizing die vary during the time the cable sheath is being extruded. Thus, just after a new charge of material to be extruded has been admitted and reaches the top of the extruding chamber it will raise the temperature of the upper portion of the extruding chamber because the new charge is usually hotter than the old charge remaining in the extrusion chamber. At the time the new charge is entered, the level of the old charge usually is about 1 inch above the top of channel 18. The portion of the old charge in the upper portion of the extrusion chamber is therefore hotter and more plastic than the lower portion of the old charge in the lower portion of the extrusion chamber. Under this condition, as extrusion begins, the upper portion of the old charge in the upper section of the extrusion chamber will flow faster than the bottom portion of the old charge in the lower portion of the extrusion chamber. The increased rate of flow of the top portion therefore results in thicker sheath which continues to increase until virtually all of the old charge has been extruded. Then as the new charge is extruded the temperature of the extrusion chamber as well as the material in it tends to become uniform so that viscosity or plasticity of the material to be extruded will approach the same value all around the cable and the thickness of the sheath will tend to return to the normal thickness which it had at the start of the extrusion cycle. It should, therefore, be possible to correct for this variations in the thickness of the cable sheath by controlling the position of the sizing die relative to the core tube in accordance with the temperature differential between the top and bottom of the sizing die. In the embodiment of the invention as shown in Fig. 5 the

relative positions of the core tube and the sizing die are varied in accordance with this temperature differential. For example, if the temperature of the top of the sizing die increases relative to the temperature of the bottom of the sizing die, the sizing die will be lowered relative to the core tube thus tending to increase the thickness of the bottom of the cable sheath and reduce the thickness on the top of the cable sheath. If, as extrusion proceeds the temperature differential between the top and the bottom of the sizing die decreases the sizing die will be raised with respect to the core tube thereby tending to maintain the thickness of the sheath constant.

In another embodiment shown in Fig. 6 of this invention the thickness of the extruded cable sheath is measured as the cable passes out of the die block through the plug 6 which holds the sizing die in the extruding block 22. As the thickness of the cable sheath on the bottom increases relative to the thickness of the sheath on the top of the cable the sizing die will be raised so that the thickness of the cable sheath will remain substantially constant on both the top half of the sheath and on the bottom half of the sheath. It will similarly be lowered when the thickness on the top half of the cable sheath tends to become greater than the thickness of the bottom half of the cable sheath again tending to maintain the thickness of the sheath constant.

The sizing die may have to be raised or lowered more than the variation in thickness of the cable sheath in all these embodiments of the invention due to the fact that as the die is raised or lowered the cable core may tend to bend or be deflected up or down further during the extrusion of the cable so that the sizing die will have to be raised still farther in order to substantially eliminate the variation in the eccentricity of the cable sheath due to the bending of the core.

Referring again to the embodiment of the invention shown in Figs. 1 and 2 the sizing die 5 is mounted in a block 4. The block 4 is arranged to slide up and down under control of the cam comprising cam surfaces 7 and 8 (see Fig. 2). This cam is mounted on a shaft 9 which is supported by bearings 32. Plain bearings 32 have been shown but it is to be understood that any suitable anti-friction bearings may be used. It is also within the scope of this invention to provide block 4 with anti-friction bearings or surfaces such as 16 shown in Fig. 1 to reduce the friction between block 4 and extruding block 22. This friction is quite high due to the high pressure of the sheath material pressing the extrusion die 5 and block 4 against block 22. These anti-friction bearings have not been shown in the other figures because they would needlessly complicate these figures without aiding in the understanding of this invention. However, it is to be understood that they may be provided in any or all of the figures or embodiments of this invention if they are desirable. Shaft 9 is driven through gears 10, 31, a clutch comprising members 29 and 30, gear 28 and rack 25 which is connected by member 26 to the extrusion ram or piston 20 by rod 27. It is to be understood that the particular configuration and relative locations of these gears, clutches, racks and member 26 as shown in Fig. 2 is for the purpose of explaining the details of this invention and is not to be considered a working drawing. For example, the configuration of members 26 would be altered considerably in practice to shorten and

strengthen them so that they would not tend to be bent or strained during the extrusion cycle. Furthermore, the configuration and location of the various parts is largely determined by the particular structure of the extrusion press. The actual shapes and relative positions of these members would be designed to fit the press to which this invention is applied. These particular elements of the invention have therefore been shown in such a manner as to enable the invention to be more readily understood. It is to be noted that cams 7 and 8 are designed to positively control the position of block 4. For example, cam 7 moves the block 4 down while cam 8 moves it up. These cams are laid out and designed in accordance with the average cyclic variation of the thickness of the cable encountered when the cable sheath is extruded on a press in which the sizing die and core tube remains substantially fixed relative to each other. The shape of these cams will vary with different sizes and types of cables, with different thicknesses of sheath, and with different materials and alloys comprising the cable sheath, with different extrusion presses and with other factors.

Figs. 4—A and 4—B show typical cam surfaces and the manner in which they may be designed in accordance with the usual cam design practice. Circles 34 are laid out and divided into a number of parts. A curve of the average variation of the thickness or eccentricity of the cable sheath during the extrusion cycle is divided into a similar number of parts and the variation of the cable sheath or some function of this variation is measured along these corresponding radial division lines of the circle. These points lie upon the surface of the cams. Assume, for example, that the variation in thickness of the top half of the sheath during the second charge or cycle is a representative or average variation of the thickness or eccentricity of the cable sheath. Then starting at A of curve 37 it is noted that the thickness of the cable sheath increases on the top. Cam surface 35 is therefore designed to move the die block 4 down as it rotates in a counterclockwise direction from the position shown in Fig. 4—A. The cam surface 36 as shown in Fig. 4—B is designed to permit die block 4 to be lowered by cam 35. After about the first eighth of the extrusion cycle cam surface 36 of cam 8 will raise the die block 4 and cam surface 35 of cams 7, will permit cam 8 to raise the die block. Near the end of the cycle cam surface 35 will again lower the die block to the starting position. This cycle will be repeated during each of the extrusion cycles during which a charge is extruded.

By providing two cams it is possible to more readily adjust surfaces engaging the cams when they wear and to prevent lost motion as well as to uniformly control the motion of block 4 and sizing die 5 when a change of direction is desired. It is to be noted that since this eccentricity of the sheath varies cyclically during the extrusion cycle the cam should return the block 4 and sizing die 5 to their initial positions at the end of the cycle. Furthermore, since each cycle is essentially the same and the cam is rotated through one cycle during each extrusion cycle the contour of the cam should be designed to include a single or whole number of extrusion cycles.

The operation of this embodiment of this invention will now be described. As the extrusion ram or piston 20 starts to descend at the

beginning of an extrusion cycle, it will force the material in chamber 19 down channel 18 into extrusion chamber 17 where it is extruded around the cable core as it passes between core tube 3 and sizing die 5. As the hot charge reaches the upper portion of the extruding chamber 17 and comes in contact with sizing die 5, it will be more plastic than the old charge and thus flow faster or be extruded easier so that the thickness of the extruded cable sheath will be increased on the top and decreased on the bottom. However, as piston 20 is forced down in cylinder 21, it also forces rack 25 down which in turn rotates gear 28 and gears 31 and 10 through the one-way clutch members 29 and 30. The rotation of gear 10 rotates shaft 9 which in turn rotates cams 7 and 8 and lowers the sizing die 5. This compensates for the tendency of the extruded cable sheath to increase in thickness, thus tending to hold the thickness of the sheath on both the top and bottom of the cable the same. As the old charge is finally all extruded from the extrusion chamber 17 and the hot new charge enters, the material then tends to become equally plastic on both the top and bottom halves of the cable sheath so that the sizing die would then have to be raised as piston 20 further descends carrying rack 25 with its further rotating gears 28, 31, 10 and cams 7 and 8. This is accomplished by the design of the contours of cams 7 and 8 as pointed out above. Then at the end of the extrusion cycle when piston 20 is raised carrying rack 25 with it in order to secure a new charge, gear 28 will again rotate with it. However, due to the action of the one-way clutch comprising members 29 and 30, gears 31 and 10 and cams 7 and 8 will not rotate. It is very desirable to provide this clutch, first because the friction of the sizing die 5 and block 4 is greatly increased during the time the cable sheath is not being extruded. Furthermore, it is very desirable not to disturb the extrusion material between cable core and the sizing die 5 during the time the sheath is not being extruded as movement at this time is apt to produce cracks or severe sizing die press marks in the sheath at this place. However, by providing a one-way clutch so that the sizing die is not disturbed by the return stroke of the extrusion cam 20 troubles of this nature are avoided.

Thus rack 25 in combination with gear 28, clutch 29, 30 and gears 31 serve to measure or indicate the position in the extrusion cycle and cams 7 and 8 adjust the relative position of the core tube and the sizing die in accordance with this measurement of the position in the extrusion cycle.

In the embodiment of the invention shown in Fig. 5 some temperature responsive means, such as thermocouples 33 and 34, are located respectively at the top and bottom of the sizing die 5. As shown in Fig. 5 these temperature responsive elements or thermocouples are embedded within the sizing die 5. It is to be understood, however, that they might be equally well located on or attached to the outside of the die in extruding chamber 17. It is also to be understood that the wires connected to these thermocouples are not actually embedded in member 6 as might be assumed from Fig. 5 but may be brought out in any convenient manner. They have been so shown in Fig. 5 merely to simplify the drawing and facilitate the understanding of the invention. These thermocouples are connected through the connecting wires to a potentiometer 35, the mov-

ing contact arm 36 of which is insulatedly supported on the shaft 9. This potentiometer is connected across the source of potential 39 and connected in series with the temperature responsive element. The series combination is then connected to the moving element of an indicating instrument 40. The potential of source 39 and the position of movable contact 36 on shaft 9 are so adjusted that when the temperature responsive elements 33 and 34 are at such a temperature that the cable sheath normally would be of the same thickness on the top as on the bottom, the potential across the potentiometer applied in series with the thermocouples just balances the potential difference of the thermocouples due to the respective temperatures of these thermocouples. Under these conditions the electrical indicating instrument 40 will be held in its neutral position. It is to be noted that if one of the thermocouples 33 or 34 is always at a higher temperature than the other of these thermocouples, the source of potential 39 may comprise a source of potential of only one polarity instead of two polarities as shown in Fig. 5.

The electrical indicating instrument 40 is mechanically connected to an amplifying arrangement comprising cores 41 and 47, motor 49 and amplifier 45. Cores 41 and 47 are energized from a source of alternating current power 44 by means of windings 42 and 48, respectively. Each of these cores is provided with a moving element 43 and 46, respectively. The moving element 43 is mechanically connected to and controlled by the indicating instrument 40. Coils 43 and 46 are connected directly in series with each other and with the input 61 of the amplifier 45. These coils are also so connected that when they are both in the same relative positions no voltage is applied to the input circuit of amplifier 45. However, when they are not in the same relative positions a voltage is applied to the amplifier 45 which is proportional to the displacement of the coils. This voltage is amplified by the amplifier 45 and applied through its output circuit 62 to the windings 54 of motor 49. Motor 49 is also energized from source 44 by winding 50. The output of amplifier 62 causes the motor armature or disc 52 to be rotated in such a direction as to move the movable element 46 in the same direction as movable element 43 was moved from its normal or preceding position by indicating device 40. When motor 49 has rotated this coil 46 so that it again occupies the same relative position as coil 43, the output of amplifier 45 falls to zero and the motor 49 stops with this coil in this position.

This type of amplifying arrangement is described in an article by H. L. Bernarde and L. J. Lucas entitled "New system for recording using electronic means" published in *Electrical Engineering*, vol. 52, March 1933, pages 168 to 170.

The output of this electronic device instead of operating a recording pen is connected to contacts 55 and 56 which in turn control relays 57 and 58, respectively. These relays are provided with contacts for connecting motor 14 to source 15. The circuit is so arranged that relay 57 in operating connects motor 14 to source 15 in such a manner that motor 14 rotates in one direction while when relay 58 is energized motor 14 is connected to source 15 so that it will rotate in the reverse direction. This motor can be of any suitable type which is capable of being driven in two directions. The motor is of sufficient power

capacity to move sizing die 5 by means of cams 7 and 8, shaft 9 and gear train comprising gears 10 and 12 in the desired direction at the required speed. As shown in Fig. 5 motor 14 may be a shunt direct current motor and source 15 a source of direct current. In this case one of the sets of leads 59 or 60 is connected to the field windings of motor 14 while the other set is connected to the commutator and armature windings of motor 14.

Motor 14 may equally well be a single phase alternating current motor in which case source 15 would comprise a source of single phase alternating current. In this case one of the pairs of leads 59 and 60 would be connected to the operating windings of motor 14 while the other set of leads will be connected to the starting winding. Other types of motors may be controlled through appropriate circuit arrangements.

If the temperature of one of the thermocouples 33 or 34 rises so that the potential across potentiometer 35 no longer balances the potential difference of the two thermocouples, indicating device 40 will respond and move element 43 of coil 41 one way or the other depending upon which way the relative temperatures of the thermocouples 33 and 34 vary. The potential then induced in movable coil 43 will no longer be equal and opposite to the potential induced in movable coil 46. Consequently, a voltage will be applied to the input circuit of amplifier 45 which, in turn, applies an amplified voltage to coil 54 of motor 49 through the output circuit 62 of amplifier 45. The output current flowing through coil 54 will cause the armature or disc 52 of motor 49 to be rotated in the direction to move movable coil 46 in the same direction as the indicating device 40 moves the movable coil 43. In moving movable coil 46 the motor 49 will also close one of the pairs of contacts 55 or 56. Assuming contacts 55 are closed, this will energize relay 57 which in turn, will energize motor 14. Motor 14 will then rotate a shaft 9 in the direction as to compensate for the expected change in thickness of the cable sheath due to the change in the relative temperature of thermocouples 33 and 34.

Had the temperature difference of the thermocouples 33 and 34 been in the opposite direction, indicating device 40 would have moved in the opposite direction which would have moved moving coil 43 in the opposite direction. This would apply a voltage 180 degrees out of phase from the voltage in the first case to the input circuit 61 of amplifier 45; the output of the amplifier would then drive motor armature or disc 52 in the reverse direction and cause contact 56 to close which, in turn, operates relay 58. This will connect motor 14 to source 15 in a manner so that motor 15 will rotate in the reverse direction and thus make a corresponding reverse change in the position of sizing die 5 with respect to cable guide 3.

As the motor 14 drives shaft 9 it also moves the movable contact 36 of potentiometer 35 so that the potential connected in series with the thermocouples 33 and 34 will be changed to compensate for the change in the potential difference of these elements. Responding device 40 will therefore return to its neutral position. This will reverse the process and cause the movable coil 43 to be returned to its normal position which in turn causes movable coil 46 to be returned to its normal position. This, in turn, will return contacts 55 or 56 to their normal positions and thus release relays 57 or 58 which in turn disconnect

motor 14 which then stops. When the motor stops the sizing die has been moved sufficient to compensate for the expected variation in the thickness of the cable sheath due to a change in the temperature recorded by these thermocouples. It should be noted that if the relation between the temperature difference of the thermocouples and the variations of the eccentricity of the cable sheath is not linear the variations of the resistance of the potentiometer may be made to vary in a corresponding manner.

It is to be understood that these changes take place continually during the extruding cycle of the press. During the recharging cycle of the extruding press it is desirable to disconnect responding device 40 from the circuit of the thermocouples 33 and 34 so that if the relative temperatures of thermocouples 33 and 34 are changed during the recharging portion of the extrusion cycle, motor 14 will not move the position of the sizing die 5 relative to cable guide 3. Such an arrangement is very desirable since, as pointed out in Fig. 1, the sizing die will be very much harder to move at this time than during extrusion. In the second place, movement of the sizing die during the recharging of the extrusion press may cause cracks, fissures, or press marks in the cable sheath and thus largely destroy the value of the sheath protecting the cable core. The circuit of thermocouples 33 and 34 may be readily interrupted by means of a suitable switching device 63 which is preferably controlled by the movement of the extrusion press. During this time the piston is descending and the cable sheath is being extruded, this switch would be closed. However, during the return stroke of the piston switch 63 would be opened so that during this time motor 14 could not be energized and therefore could not move the sizing die with respect to the cable guide.

In the embodiment of the invention shown in Fig. 6, variations of the thickness of the cable sheath, or the difference in the variations of the thickness of the top and bottom of the sheath is measured as the cable is extruded from the extruding block 22 through the retaining member 6 which retains the sizing or extruding die. This measuring apparatus is represented in Fig. 6 by a member 69 which may be supplied with power from a source 71. This measuring device may be of any suitable type or form which is capable of determining either actual thickness, the relative thickness of different portions, or variations of the actual or relative thickness of the cable sheath without injuring the sheath. Examples of measuring apparatus suitable for use for measuring the thickness of the cable sheath without injuring it are disclosed in the following United States patents: 1,815,710 granted to E. A. Guillemin on July 21, 1931; 1,815,717 granted to H. E. Kranz on July 21, 1931; 1,985,277 granted to F. D. Braddon on December 25, 1934, and 1,946,189 granted to F. D. Braddon et al. on February 6, 1934. Any or all of the methods disclosed in these patents or suitable modifications thereof are suitable for use in the embodiment of this invention shown in Fig. 6. The disclosures of these patents are therefore hereby made part of this specification as if fully included herein. In the measuring devices disclosed in the Braddon patents it may be desirable to provide additional sets of contacts and arranging these contacts so that one set makes contact with the top of the cable and another contact set makes contact with the bottom of the cable and so that these contacts

remain in these relative positions during the extrusion.

An amplifier 70 may be included with the measuring device 69 or may be in addition to any amplifying device associated with the measuring equipment 69. The output of amplifier 70 is then connected to the moving element of the indicating instrument 40 which in turn controls the amplifying arrangement including amplifier 45 through movable coils 43 and 46 of coils 41 and 47, respectively, which are energized from source 44 by windings 42 and 48 similar to the arrangement shown in and described with reference to Fig. 5. In addition to measuring the variation of the thickness of the cable sheath or its eccentricity, these electrical measuring devices also detect cracks or fissures in the cable sheath. Inasmuch as these cracks or fissures are usually very small, they will cause abrupt changes in the output of the measuring device 69 or amplifier 70, whereas the eccentricity or variation in thickness of the sheath changes quite gradually, and will, therefore, cause only gradual changes in the output of the measuring device 69 or amplifier 70. In addition, the changes due to the fissures are usually of greater amplitude than the changes due to the variation in thickness or eccentricity of the cable. It is therefore desirable to prevent any of these abrupt changes in the output due to cracks or fissures in the cable sheath from disturbing the adjustment of the relative positions of the cable core and sizing die and thus increasing the eccentricity of the cable sheath. This may be accomplished by inserting a filter 64 either between the output of the measuring device 69 and amplifier 70, or between the amplifier 70 and indicating device 40 as shown in Fig. 6. This filter is designed to pass only the very low frequencies due to the slow variations of the output of amplifier 70 or measuring device 69 to indicating device 40 thus preventing a rapid movement of this indicating device due to cracks or fissures in the cable sheath. However, these rapid variations due to fissures or cracks in the cable sheath may be used to operate an alarm or indicating circuit 65 through filter 72 which may be provided to prevent interaction between 65 and indicating device 40. The circuit or device 65 may be of any suitable or convenient type as, for example, lighting a light, ringing a bell, stopping the extrusion press, or applying a distinguishing mark to the cable sheath in the proximity of the fissure or crack.

In the embodiment of the invention shown in Fig. 6 the output of motor 49 is connected through gears to shaft 66. Shaft 66 in turn controls a torque amplifier of any suitable type. The type illustrated in Fig. 6 is fully described in an article published in the American Machinist for May 26, 1927, beginning on page 895, entitled, "Bethlehem torque amplifier" which description is hereby made part of this application as if fully included herein.

Briefly, this torque amplifier comprises a motor 14 for supplying the power to the amplifier. Motor 14 is supplied with power from source 15 and continuously rotates shaft 13, gears 12, 10 and 11. Gears 10 and 11 rotate in opposite directions and are rotatably mounted on shaft 9. Gears 10 and 11 are provided with friction or brake drums 68 and 67, respectively. Inside these friction or brake drums an expansible friction or brake band is provided. These brake bands are controlled by shaft 66. When shaft 66 is turned in one direction, one of these brake or

friction bands expands so that it engages its associated drum 67 or 68. These friction or brake bands are rigidly fastened to the shaft 9. Thus, when shaft 66 is rotated and causes one of these bands to expand and engage its corresponding drum, shaft 9 will be rotated by the corresponding gear 10 or 11 as long as shaft 66 is rotated and maintains the friction band expanded against the cooperating friction drum.

When shaft 66 stops and shaft 9 has turned as far as shaft 66 has been turned, further rotation of the drum 67 or 68 will cause the brake band to be contracted and disengage the drum whereupon the shaft 9 is stopped. Thus, a small torque applied to shaft 66 is greatly amplified by the arrangement so that a very large torque is applied to shaft 9 under control of a very small torque applied to shaft 66.

Mounted on shaft 9, as the embodiment is shown in Fig. 5, is a potentiometer 35 connected to a source of potential 39. As shown in Fig. 6, only a single polarity of potential has been provided for source 39. It is to be understood, however, that a source 39 of both positive and negative potential may be employed.

The operation of the embodiment as shown in Fig. 6 is quite similar to the embodiment shown in Fig. 5. As the cable is extruded, measuring device 69 measures variations in the thickness of the cable sheath or variations in eccentricity of the sheath is varying in one direction, for example, increasing in thickness on the bottom and decreasing in thickness on the top, the output of amplifier 70 changes slowly in accordance with the variation in the eccentricity of the cable sheath. This slow variation in the output of amplifier 70 passes through filter 64 and actuates indicating device 40 which in turn moves the movable coil 43 of the alternating current coil 41. This applies the voltage to the input circuit of amplifier 45 which is amplified and applied to motor coils 54 which are connected to the output circuit of this amplifier 45. The output current flowing through coils 54 causes the armature 52 of motor 49 to rotate which in turn causes the movable coil 46 of the alternating current coil 47 to be rotated in a corresponding manner. When coil 46 assumes the same position as coil 43, the input of amplifier 45 will be reduced to zero. The output of amplifier 45 will likewise be reduced to zero so the armature or disc 52 of motor 49 will stop in this position. Shaft 66 is also connected to the disc 52 of motor 49 through a suitable gearing. The rotation of shaft 66 by motor 52 causes a corresponding rotation of shaft 9 through the torque amplifier which is driven by motor 14 through gears 10, 11 and 12 and friction drums 67 and 68 and associated clutches and equipment. The rotation of shaft 9 controls the relative position of the sizing die and core tube. These particular elements are not disclosed in Fig. 6, but it is to be understood that they are similar in construction to the embodiment of the invention illustrated in Figs. 1, 2 and 5. This rotation of shaft 9 will be in a direction to move the sizing die to reduce the change in the eccentricity of the cable sheath. Under the conditions assumed the sizing die will be raised with respect to the core tube thus tending to make the thickness of the sheath on the bottom of the cable decrease while that on the top increases thus offsetting the variation in the thickness of the cable sheath on the top and bottom of the cable.

As the thickness of the cable sheath approaches its former value, namely the same on the top and bottom, the output of amplifier 70 will change in the opposite direction to the former assumed direction. This would cause the indicating device 40 to reverse thus reversing the rotation of shaft 66 and shaft 9 which would then tend to move the sizing die and cable core so as to again cause a decrease in thickness of the cable sheath on top of the cable and an increase in thickness of the cable sheath on the bottom of the cable. To prevent this potentiometer 35 is provided and connected in series with the indicating device 40. This potentiometer is controlled by shaft 9 in such a manner that as the cable sheath approaches its old value, namely of equal thickness on the top and bottom, there is a corresponding change in the potential applied to indicating device 40 which substantially prevents this indicating device from returning to its former position unless the cable sheath actually increases in thickness on top and decreases on the bottom.

It is to be understood that these changes or variations in the thickness of the cable sheath and also the adjustments of the sizing die take place very slowly and more or less continuously during extrusion of the cable sheath.

As before, it is desirable to prevent any relative movement of the core tube and the sizing die during the time the extruding press is being recharged with the extrusion material. It should be noted that in this embodiment of the invention a switch similar to switch 63 cannot satisfactorily be connected in series with indicating device 40 because indicating device 40 should not return to its normal position during the recharging portion of the extrusion cycle. However, various other arrangements may be provided such as providing a switch similar to switch 63 in the circuit of motor 14 to cause the motor 14 to stop during this time, or a suitable mechanical locking arrangement may be employed to lock shaft 66 in the position in which it was last set by motor 49 at the end of the extrusion cycle. Any other suitable arrangement may also be provided. It is to be noted, however, that in case the thickness of the sheath of the cable is measured on both top and bottom of the cable sheath, such a locking arrangement will in some cases be unnecessary in the embodiment of the invention shown in Fig. 6 since even though the properties of the cable sheath change with the temperature during the time the sheath is stationary and cooling when the extrusion press is being recharged, these variations will be substantially the same on both the top and bottom of the cable sheath and thus tend to be eliminated. Consequently, special locking or disengaging devices are not as necessary in this embodiment as in the embodiment disclosed in Figs. 1, 2 and 5.

It is to be understood that the specific embodiments of this invention above described may be varied as desired. For example, the torque amplifier may be provided in the embodiment of the invention as shown in Fig. 5, or the motor control arrangement shown in the embodiment in Fig. 5 may be employed in the embodiment of the invention shown in Fig. 6. Both the motor control shown in Fig. 5 and the torque amplifier shown in the embodiment in Fig. 6 may be employed in which case the motor 14 of Fig. 5 would control either directly or through a suitable gearing, shaft 66 of the torque amplifier as shown in Fig. 6. It is therefore evident that

there may be many similar combinations of the various elements within the scope of this invention which need not be specifically described.

What is claimed is:

1. A method of controlling the eccentricity of extruded lead cable sheaths comprising measuring the temperature difference of various parts of the sizing die and continuously varying the relative positions of the core tube and the sizing die during the extension cycle in accordance with this temperature difference.

2. A method of controlling the eccentricity of extruded lead cable sheaths comprising measuring the variation of thickness of the cable sheath at more than one position around the cable throughout its extrusion and controlling the relative positions of the core tube and sizing die throughout the extrusion of the sheath in accordance with the variations in the thickness of the sheath at different points around the cable whereby the eccentricity of the sheath is substantially eliminated.

3. In a lead press for extruding lead cable sheaths, a core tube, a sizing die, means for varying the relative positions of said core tube during the extrusion of said sheath and sizing die and an operative connection between said means and said lead press.

4. In a lead press for extruding lead cable sheaths, a core tube, a sizing die, temperature responsive elements for measuring the temperature difference of different parts of said die and means for varying the relative positions of said die and tube, an operative connection between said means and said temperature responsive elements.

5. In combination, a lead press for extruding lead cable sheaths comprising a core tube, a sizing die, means for varying the relative positions of said sizing die and core tube and means for continuously measuring variations of the thickness of the cable sheath at different positions around said cable as said sheath is extruded, and an operative connection between said measuring means and said means for varying the relative positions of said tube and die whereby variations in the relative thickness of said sheath at different positions around said cable are substantially eliminated.

6. In a lead press for extruding lead cable sheaths comprising a core tube, a sizing die, means for continuously varying the relative positions of said core tube and sizing die during the extension of the cable sheath, a lead reservoir, an extruding chamber, a connecting channel between said reservoir and said chamber, an extrusion ram in said reservoir, operative connection between said ram and said varying means.

7. In a press for extruding cable sheaths, an extruding chamber, a core tube therein, a sizing die therein, a cam for varying the position of said sizing die, an extrusion cylinder, a connection between said cylinder and said extrusion chamber, a piston operating in said cylinder to force said material into said extrusion chamber whereby a sheath is extruded around said cable, an operative connection between said piston and said cam for rotating said cam during the extrusion stroke of said piston, and means for disengaging said operative connection during the return stroke of said piston.

8. In an extrusion press for extruding cable

sheaths, a core tube, a sizing die, a plurality of thermocouples located in different positions on said sizing die, cams for changing the position of said sizing die relative to said core tube during the extrusion of said cable sheath, a motor for driving said cam, an electrical indicator, a circuit connecting said thermocouples and indicator whereby said indicator indicates the difference in temperature of the respective thermocouples, an amplifying arrangement connected to said indicator, and control means for controlling said motor connected to said amplifier.

9. In combination, a press for extruding cable sheaths comprising a sizing die, a core tube, cam operated means for varying the relative positions of said core tubes and sizing die during the extrusion of cable sheaths, means for measuring the relative electrical properties of said cable sheath at different places around said cable, amplifying means and an operative connection between said measuring means and said amplifying means and said cam for rotating said cam in accordance with the difference in electrical properties of said sheath at the respective positions around the cable.

10. In combination, a press for extruding cable sheaths comprising an extruding chamber, a core tube located therein, a sizing die located therein, cam operated means for varying the position of said sizing die with respect to cable guide during the extrusion of cable sheaths, electrical means for continuously measuring a factor relating to the eccentricity of said cable sheaths, an electrical amplifier, an electrical indicator, and a mechanical amplifier operatively connected together between said electrical measuring apparatus and said cam whereby said cam continuously controls the relative positions of said sizing die and said core tube during extrusion whereby variations in the eccentricity of said cable sheath are substantially eliminated.

11. In combination, a lead press for extruding cable sheaths comprising a core tube, a sizing die, and means for continuously varying the position of said sizing die relative to said core tube during the extrusion of lead cable sheaths, measuring means for continuously measuring some function variable with the eccentricity of the extruded cable sheath and an operative connection between said measuring means and said varying means.

12. A method of controlling and reducing the eccentricity of cable sheaths which comprises making measurements of a factor related to the eccentricity of the cable sheath throughout the extrusion thereof and varying the relative positions of the core tube and sizing die throughout the extrusion of said cable sheath in accordance with said measurements in a manner to reduce the eccentricity of said sheath.

13. A method of controlling the eccentricity of extruded lead cable sheaths comprising measuring the variation of thickness of the cable sheath throughout its extrusion and controlling the relative positions of the core tube and sizing die throughout the extrusion of the sheath in accordance with the measured variations in the thickness of the sheath whereby the eccentricity of the sheath is substantially eliminated.