Sept. 29, 1953 C. A. BRAUCHLER 2,653,373

COLLAPSIBLE DIE FOR FORGING CRANKSHAFTS

Filed Dec. 27, 1947 5 Sheets-Sheet 1

Fig. 1

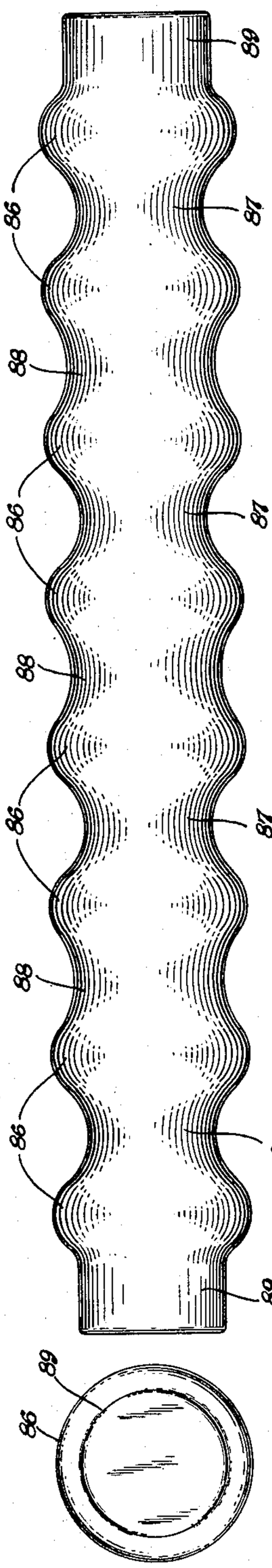

Fig. 3

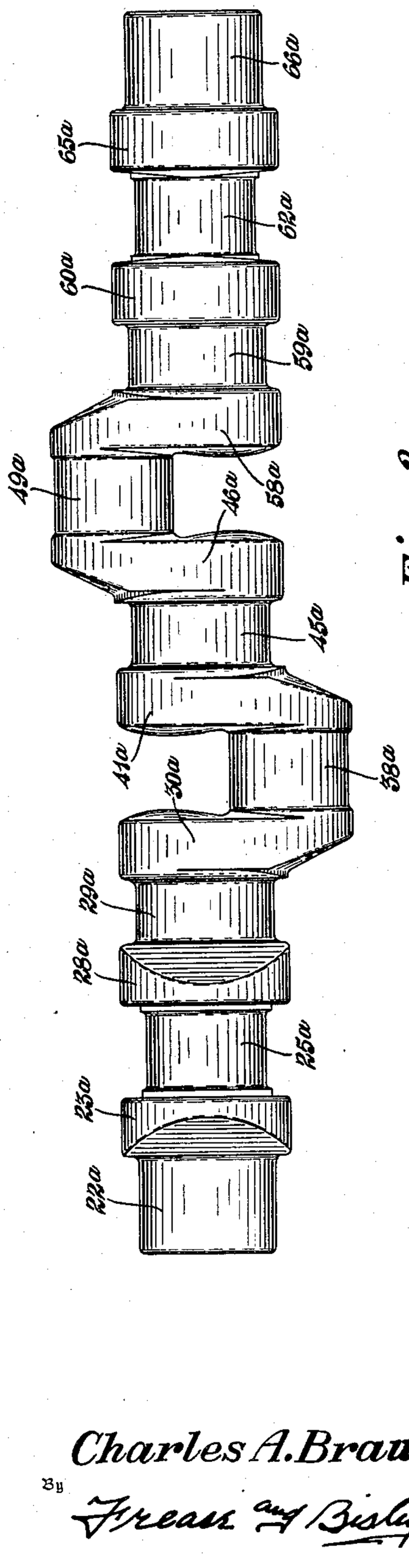

Fig. 2

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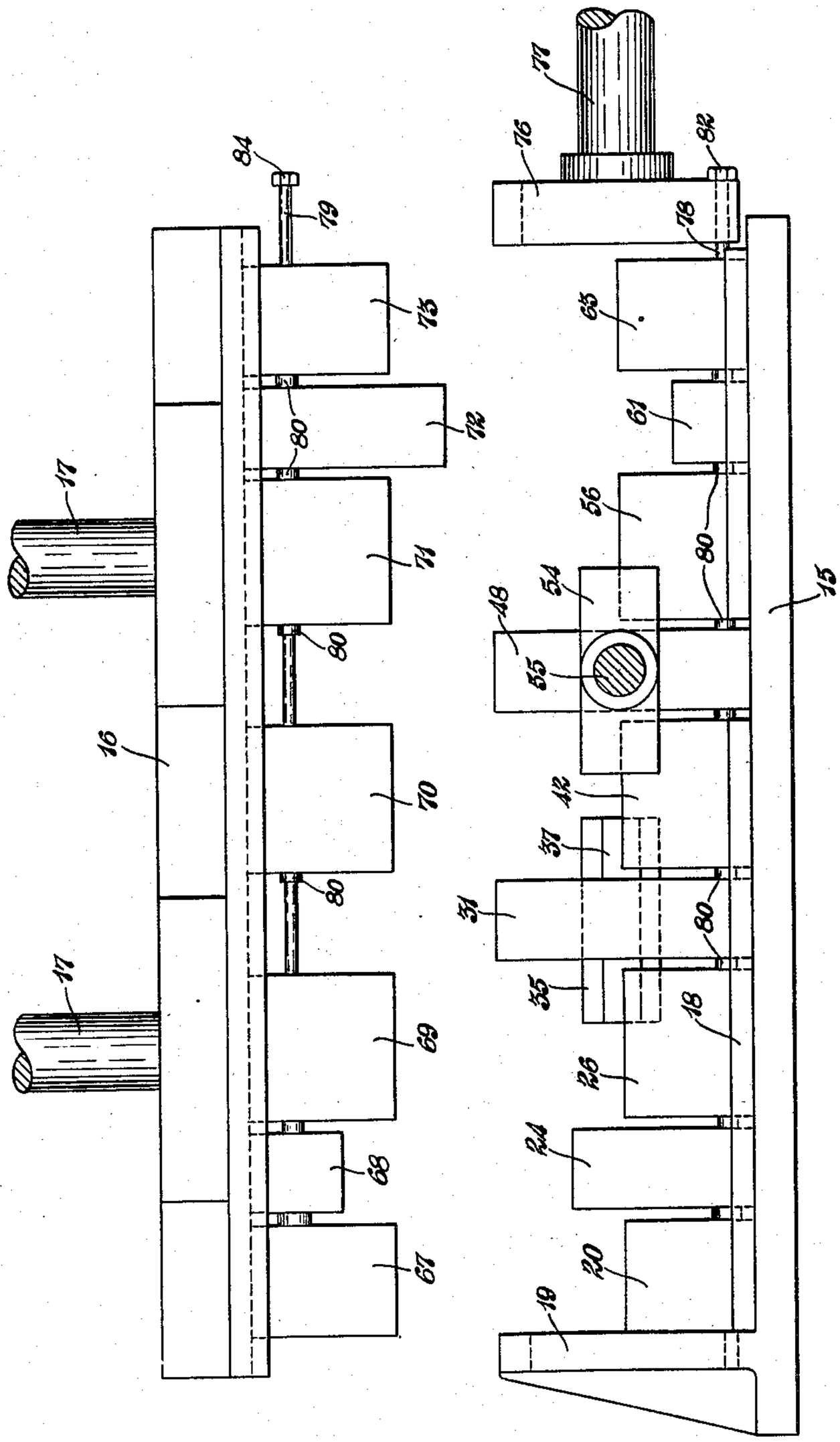

Fig. 4

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COLLAPSIBLE DIE FOR FORGING CRANKSHAFTS

Filed Dec. 27, 1947 5 Sheets-Sheet 3

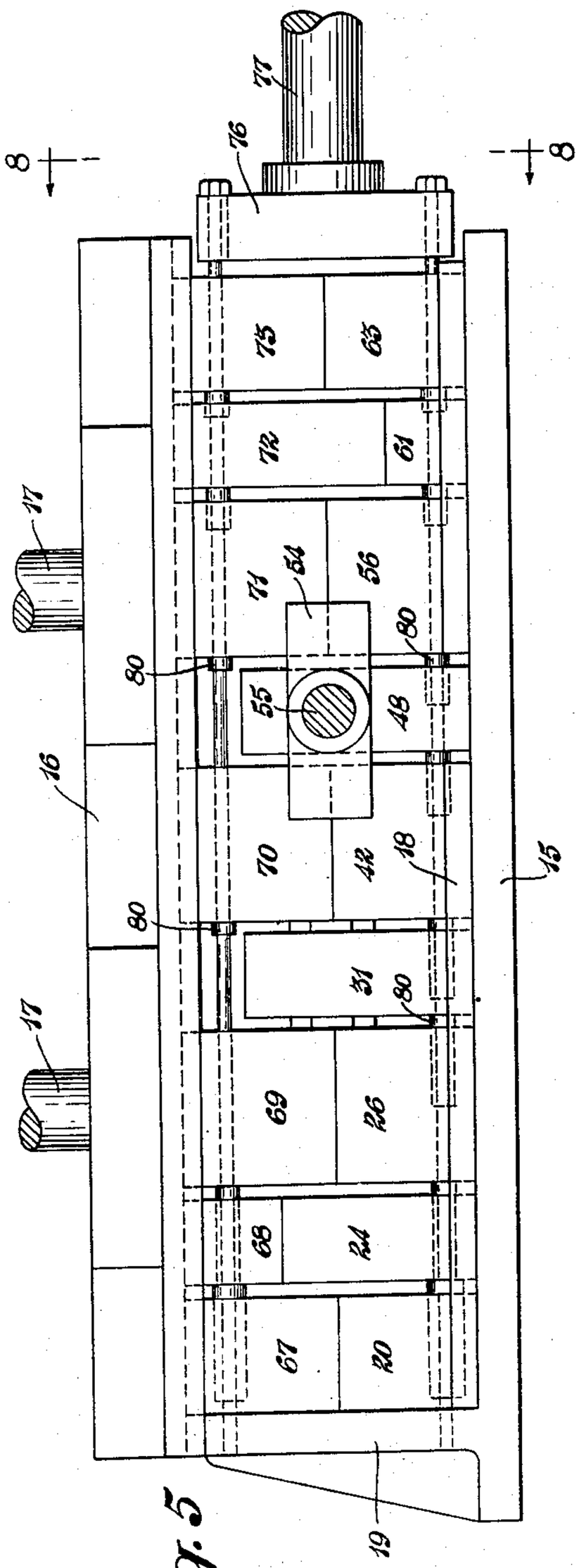

Fig. 5

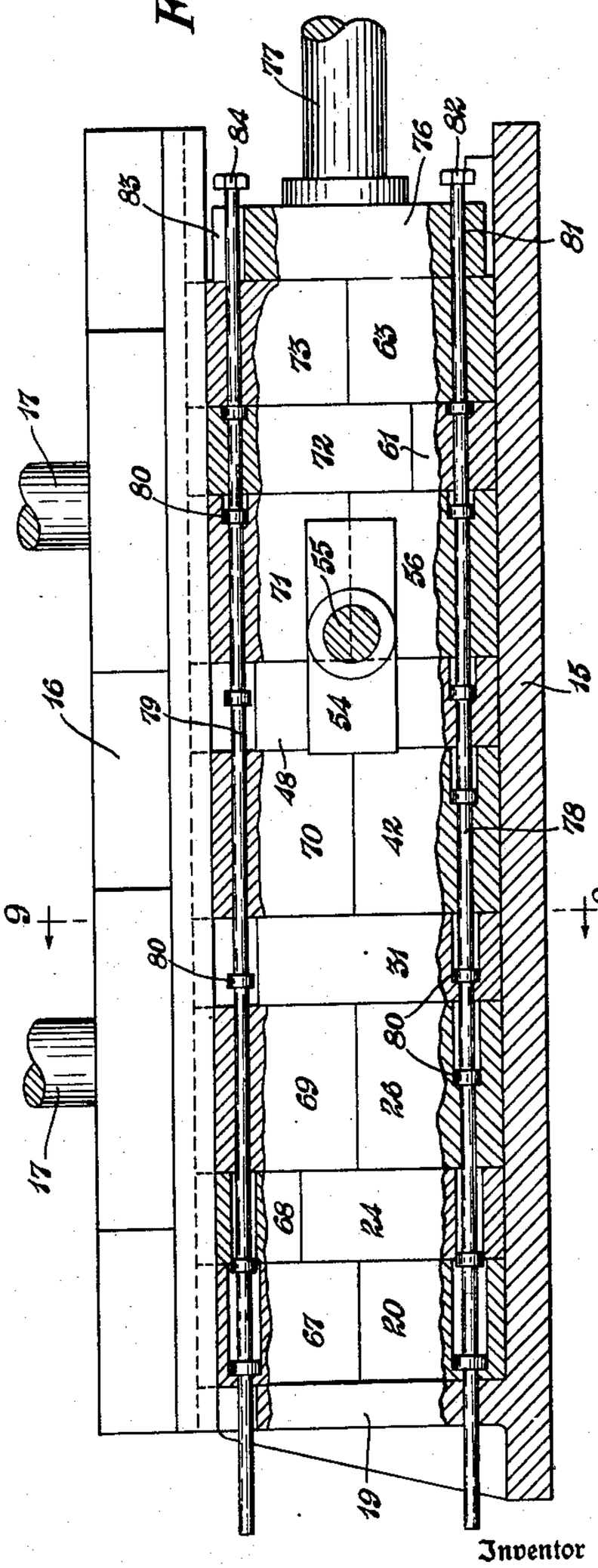

Fig. 6

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COLLAPSIBLE DIE FOR FORGING CRANKSHAFTS

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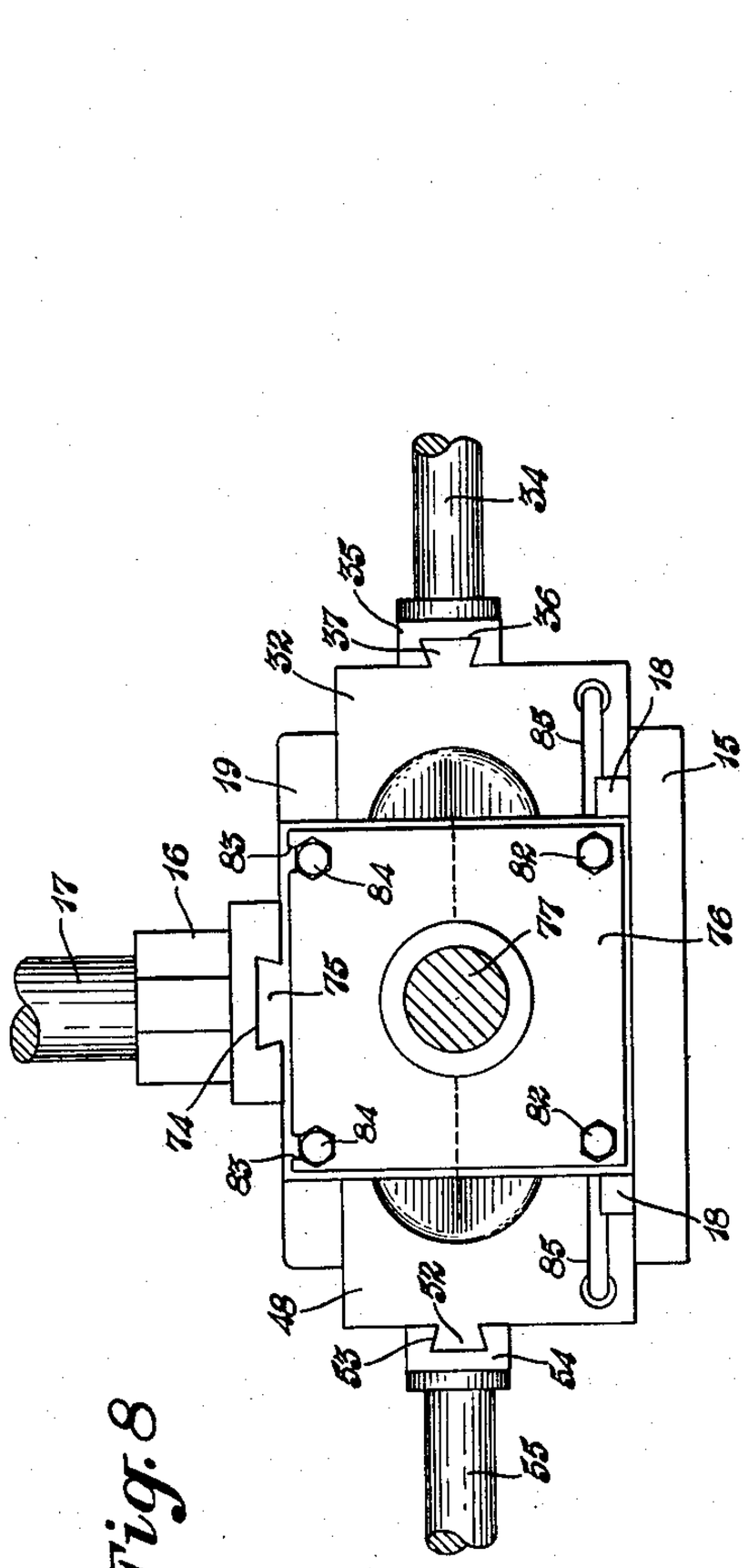

Fig. 8

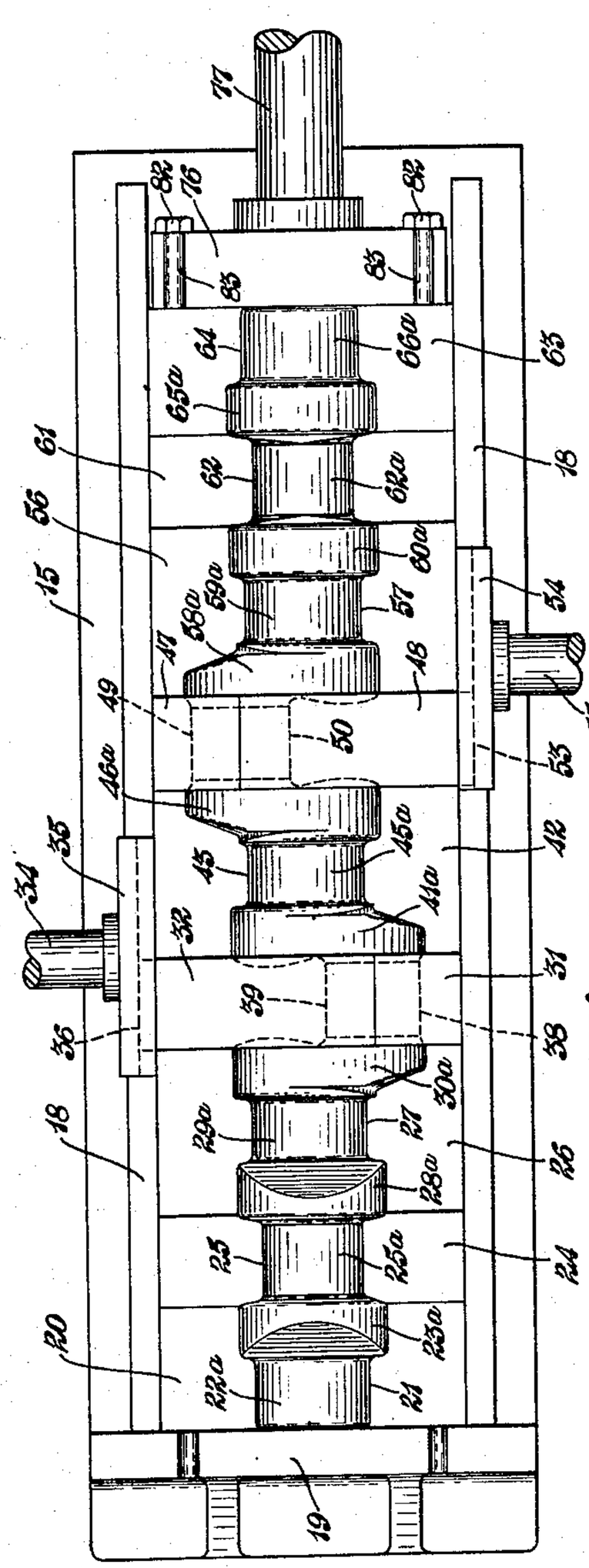

Fig. 7

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COLLAPSIBLE DIE FOR FORGING CRANKSHAFTS

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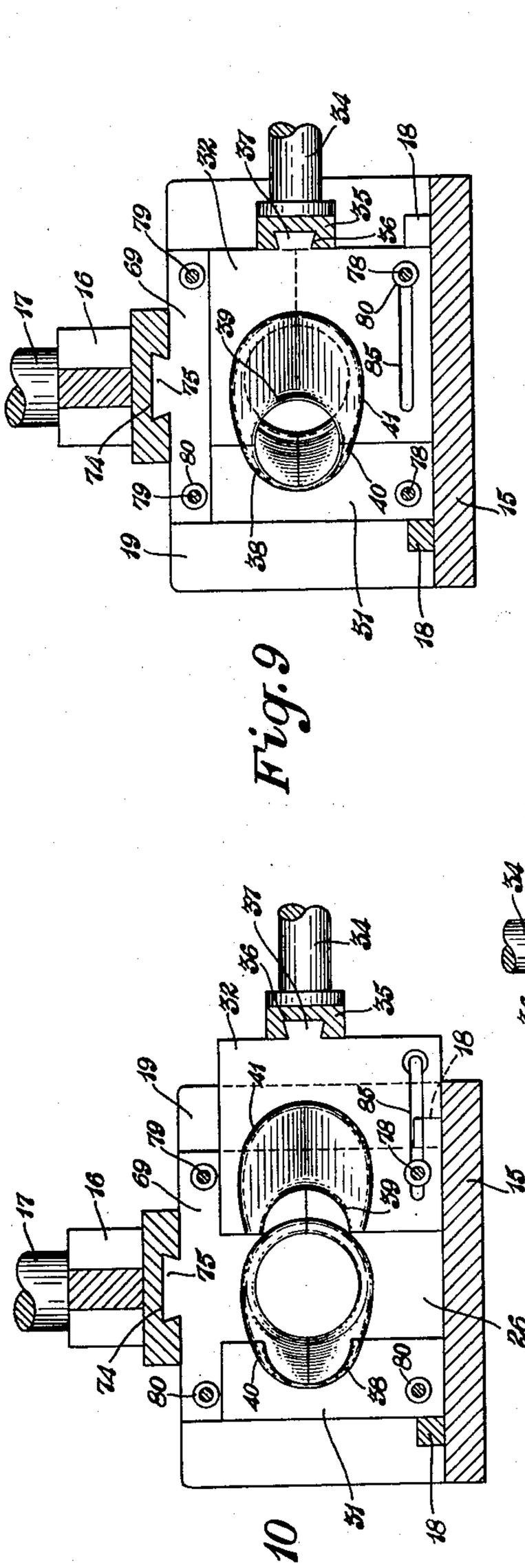

Fig. 9

Fig. 10

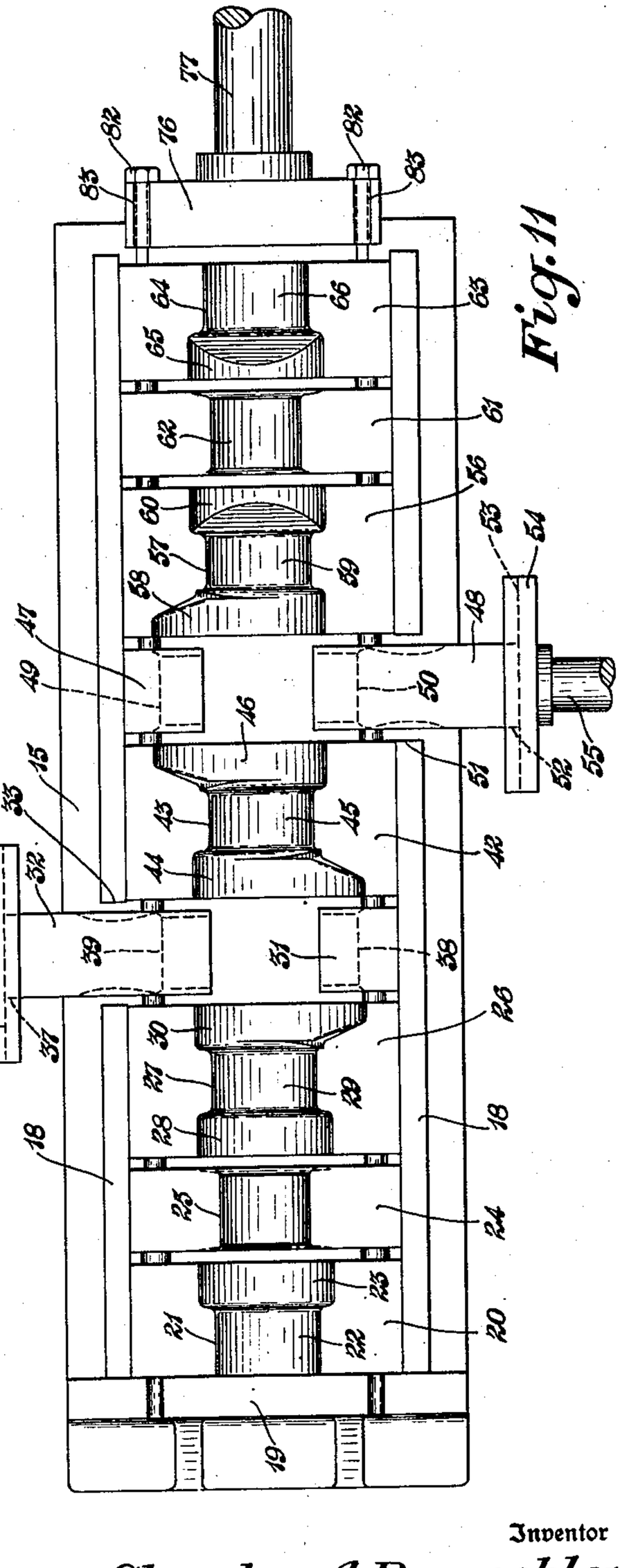

Fig. 11

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2,653,373

COLLAPSIBLE DIE FOR FORGING CRANKSHAFTS

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4 Claims. (Cl. 29—6)

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The invention relates to the manufacture of crankshafts and more particularly to collapsible dies for forging a complete crankshaft to finished shape in a single forging operation.

In the manufacture of crankshafts under present practice it is customary to either forge the entire crankshaft "flat," that is with all of the throws or cranks located in the same plane, after which the main bearing portions of the crankshaft are axially twisted to position the various throws or cranks at the desired relative angle to each other; or the several throws or cranks are separately forged and then the several separate throws or cranks are welded together at their ends to form the complete crankshaft.

There are certain objections to both of these methods. The twisting of the main bearing portions of the crankshaft is objectionable as it sets up strains and stresses in the metal which tend to weaken the crankshaft at these points. Also, the large dies required for forging the entire crankshaft "flat," are very expensive to produce, especially in the manufacture of very large crankshafts such as are used in large diesel engines for railroad locomotives, marine use and the like, and since these dies are subjected to excessive impact or pressure in the forging operations, the dies are frequently cracked or broken.

And in the other method, where the throws or cranks are separately formed and then welded together, the welding operations are slow, expensive and not entirely satisfactory, and change the structure of the metal at these points.

It is therefore an object of the present invention to generally improve and simplify the manufacture of crankshafts, so as to eliminate the objections and disadvantages of present practice so as to produce a superior crankshaft forging at considerably less expense and in a shorter time.

Another object is to provide a novel set of collapsible dies wherein the finished crankshaft forging with all throws or cranks located at the desired relative angles to each other, is produced in a single forging operation.

A further object is to provide dies of the type referred to comprising a plurality of lower dies longitudinally slidable upon the bed plate of a press or the like, and a plurality of complemental upper dies longitudinally slidably upon the head of the press, with means for normally spacing said dies longitudinally and means for moving said lower and upper dies longitudinally upon the bed plate and head of the press respectively, into contact with each other.

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A still further object is to provide such dies including transversely movable die blocks for forming certain parts of the crankshaft and means for moving said transversely movable die blocks longitudinally with the other die blocks.

It is another object of the invention to provide dies of the character referred to having means, including shouldered rods slidably located through the die blocks, for separating the die blocks longitudinally after each forging operation.

A further object is to provide such dies having means, including a plunger or ram cooperating with said slidable rods, for moving all of the slidably mounted die blocks into contact with each other.

The above objects together with others, which will be apparent from the drawings and following description or which may be later referred to, may be attained by constructing and operating the improved dies in the manner hereinafter described in detail and illustrated in the accompanying drawings, in which;

Figure 1 is a side elevation of a formed blank which is preferably used in the improved dies for forging a crankshaft;

Fig. 2 an end elevation of the blank;

Fig. 3 a side elevation of a conventional crankshaft which may be forged in the improved dies;

Fig. 4 a side elevation of the improved dies to which the invention pertains showing them in the open position;

Fig. 5 a side elevation of the dies with the upper dies in lowered position;

Fig. 6 a side elevation of the dies in completely closed or collapsed position, with parts broken away for the purpose of illustration;

Fig. 7 a top plan view of the lower die only, in the collapsed position shown in Fig. 6;

Fig. 8 a transverse section taken as on the line 8—8, Fig. 5;

Fig. 9 a transverse section taken as on the line 9—9, Fig. 6;

Fig. 10 a view similar to Fig. 9 with the transversely movable dies in open position; and

Fig. 11 a top plan view of the lower dies in the open or normal position.

Briefly the invention comprises collapsible or movable forging dies for forming a complete crankshaft having any desired number of throws or cranks located at the proper angles to each other in a single forging operation.

For this purpose the invention comprises a series of lower dies, normally slightly separated from each other, mounted for longitudinal slid-

ing movement upon the bed or table of a forging press or hammer, certain of the lower dies being also mounted for transverse sliding movement, and a series of complemental upper dies, normally slightly separated from each other and mounted for longitudinal sliding movement upon the vertically movable head or ram of the forging press or hammer, with means for longitudinally moving all of the dies of both the lower and upper series into contact with each other.

Although the improved dies are applicable to the forging of a crankshaft having any desired number of throws or cranks located at any angles to each other which may be desirable or necessary, for the purpose of illustration the dies are shown as designed for forming a conventional type of crankshaft having four throws or cranks which are located at angles of 90° and 180° to each other.

Referring now particularly to the construction of dies illustrated in the accompanying drawings, the bed or table of a forging press or hammer is indicated generally at 15 and the vertically movable head is indicated at 16 and adapted to be raised and lowered in conventional manner by any suitable ram means such as one or more pistons 17 which may be operated by fluid controlled cylinders of conventional construction.

A series of lower die blocks is mounted for independent longitudinal sliding movement upon the bed or table 15. For this purpose the bed may have a box formed thereon comprising the spaced, parallel, longitudinally disposed ribs 18 near opposite sides thereof and the end wall 19 at one end thereof forming a stop for the adjacent endmost lower die block 20 and the complemental upper die block therefor as will be later explained.

The die block 20, as best shown in Figs. 7 and 11, has a cavity 21 therein having the portion 22 for forming one-half of a main bearing portion 22*a* at one end of the crankshaft and the portion 23 for forming a portion of one cheek 23*a* of a throw or crank.

The next adjacent lower die block 24 has a cavity 25 therein for forming one-half of a crank pin 25*a* of the crankshaft. The next adjacent lower die block 26 has the cavity 27 therein, having the portion 28 for forming a portion of the other cheek 28*a* for the pin 25*a*, a portion 29 for forming one-half of the main bearing portion 29*a* of the crankshaft, and the portion 30 for forming one-half of the cheek 30*a* of the crankshaft.

A pair of complemental die blocks indicated generally at 31 and 32 are located next in order upon the bed 15, the die block 31 being mounted for longitudinal movement only while the die block 32 is mounted for both transverse and longitudinal movement.

For this purpose a portion of the adjacent rib 18 of the bed is cut away, as indicated at 33, and the die block 32 is mounted for transverse sliding movement upon the bed 15 by means of any suitable ram or plunger, such as the piston 34 of a fluid operated cylinder.

In order to permit the die block 32 to slide longitudinally upon the bed 15 relative to the plunger 34, an elongated head 35 is carried by the plunger and provided with a dove tail groove 36 in which is slidably mounted the dove tail lug 37 formed upon the die block 32.

The die block 31 has a cavity 38 in its inner side shaped to form one-half of the crank pin 38*a*, and the die block 32 has a complemental cavity 39 which forms the other half of said crank pin, and these two dies have the cavity portions

40 and 41 in opposite sides for forming the opposed side faces of the cheeks 30*a* and 41*a* respectively, which carry the crank pin 38*a*.

A die block 42 is located upon the bed adjacent to the die blocks 31 and 32 and has a die cavity 43 in its upper face having the portion 44 which forms substantially one-half of the cheek 41*a* of the crankshaft, the portion 45 which forms one-half of the main bearing portion 45*a* of the crankshaft and the portion 46 which forms substantially one-half of the cheek 46*a*.

Next to the die block 42 is located a pair of die blocks 47 and 48, similar to the die blocks 31 and 32, but reverse in position relative thereto. The die block 47 is mounted for longitudinal sliding movement only upon the bed 15 and has in its inner face a die cavity 49 shaped to form one-half of the crank pin 49*a* of the crankshaft, and the die block 48 has in its inner face a die cavity 50 shaped to form the other half of said crank pin.

The die block 48 is mounted for both longitudinal and transverse sliding movement upon the bed 15 and for this purpose the adjacent rib 18 of the bed is cut away as indicated at 51 and this die block has a dove tail lug 52 slidably located within the dove tail groove 53 of the head 54 carried by the plunger 55.

The die block 56, which is mounted for longitudinal movement upon the bed 15 adjacent to the die blocks 47 and 48, has the die cavity 57 in its upper face having the portion 58 for forming one-half of the cheek 58*a* of the crankshaft, the portion 59 for forming one-half of the crank pin 59*a* and the portion 60 for forming one-half of the cheek 60*a*.

The next lower die block 61 has the die cavity 62 therein for forming one-half of the crank pin 62*a*, and the endmost lower die block 63 has the cavity 64 therein provided with a portion 65 for forming one-half of the cheek 65*a* and a portion 66 for forming one-half of the end main bearing portion 66*a* of the crankshaft.

A series of upper dies 67, 68, 69, 70, 71, 72 and 73 are longitudinally slidably mounted upon the head 16 and located directly above the lower dies 20, 24, 26, 42, 56, 61 and 63 respectively, and have in their under surfaces die cavities complemental to the cavities in said lower dies for forming the other half of the main bearing portions, cheeks and crank pins of the crankshaft.

For the purpose of longitudinally, slidably mounting these upper die blocks in the head 16, a longitudinally disposed dove tail groove 74 is formed in the under side of the head to receive the dove tail lugs 75 upon the tops of the upper die blocks.

For the purpose of slidably moving all of the lower and upper die blocks longitudinally, to the left as viewed in the drawings, a head 76 is provided at the right hand end of the dies, operated by any suitable ram or plunger such as the piston 77 of a fluid operated cylinder.

In order to slide the die blocks longitudinally toward the right as viewed in the drawings, to separate them after each operation, a plurality of longitudinally disposed rods 78 and 79 are slidably located through the lower and upper die blocks respectively and provided at properly spaced intervals with shoulders or collars 80 for engaging the various die blocks and moving them back to the normal open position as shown in Figs. 4 and 5.

The lower rods 78 are slidably located through suitable apertures 81 in the head 76 and provided at their outer ends with shoulders or col-

lars **82** for contacting the outer side of the head and the upper rods **79** are adapted to be received in the grooves **83**, open through the top of the head **76**, and are also provided with collars or shoulders **84** for engaging the outer side of the head.

The transversely sliding blocks **32** and **48** are provided with transversely disposed horizontal slots **85** to receive the lower rods **78** and permit sliding movement of these die blocks relative thereto.

Although the crankshaft may be forged in these dies from a bar blank of suitable dimensions it is preferable that a formed blank, such as indicated in Figs. 1 and 2, be produced by rolling or otherwise, this blank having spaced pairs of annular enlargements **86** to form the cheeks of the crankshaft with intervening reduced portions **87** for forming the crank pins, the pairs of enlargements **86** being separated by the portions **88** which form the intermediate main bearing portions of the crankshaft, and the end portions **89** of the blank forming the two main bearing portions at the ends of the crankshaft.

In the operation of the improved dies, with the head **16** raised and the die blocks in the separated position as shown in Fig. 4, the heated blank as shown in Fig. 1, is placed upon the lower die blocks and the head is lowered until the complemental upper and lower die blocks are in contact with each other after which the rams **34** and **55** are operated to move the die blocks **32** and **48** transversely into contact with the complemental die blocks **31** and **47** respectively, forging the two intermediate throws of the crankshaft in a substantially horizontal plane, at an angle of 180° to each other and at angles of 90° to the two endmost throws which have been forged by the lowering of the upper dies.

The ram **77** is then operated to move the head **76** toward the left as viewed in the drawings, moving all of the lower and upper die blocks longitudinally toward the left and into contact with each other as shown in Fig. 7, this last step forging the side faces of the cheeks of the crankshaft and completing the crankshaft forging as shown in Figs. 3 and 7.

When it is desired to return the die blocks to the separated position shown in Fig. 4, the ram **77** is moved in the opposite direction, the head **76** drawing the sliding rods **78** and **79** to the right, the shoulders or collars **80** upon the rods engaging the various die blocks and sliding them to the right, separating them from each other, as shown in Fig. 5.

From the above it will be evident that an improved crankshaft forging is produced with a minimum of labor, as one complete operation of the dies will forge the crankshaft to finished shape with all throws or cranks located at the desired angles to each other, thus overcoming the objections to present conditions by eliminating the twisting or welding operations now in common use in the manufacture of crankshafts.

I claim:

1. Dies for forging a crankshaft comprising a stationary bed, longitudinal ribs at the longitudinal edges of said bed, a transversely disposed wall at one end of the bed, a series of normally separated die blocks independently longitudinally movable upon said bed between the ribs thereon, a vertically movable head above the bed, means for moving said head toward and from the bed, a series of normally separated, independently, longitudinally movable die blocks carried by the head and corresponding with the die blocks upon the bed to form cooperating pairs of upper and lower die blocks, a pair of transversely disposed die blocks independently longitudinally movable upon the bed, one of said transversely disposed die blocks being also transversely movable relative to the other, a ram engaging an endmost die block of each series for moving the die blocks of each series into contact with each other and against the end wall, and means for moving said transversely movable die block relative to the other transversely disposed die block.

2. Dies for forging a crankshaft comprising a stationary bed, longitudinal ribs at the longitudinal edges of said bed, a transversely disposed wall at one end of the bed, a series of normally separated die blocks independently longitudinally movable upon said bed between the ribs thereon, a vertically movable head above the bed, means for moving said head toward and from the bed, a series of normally separated, independently, longitudinally movable die blocks carried by the head and corresponding with the die blocks upon the bed to form cooperating pairs of upper and lower die blocks, a pair of transversely disposed die blocks independently longitudinally movable upon the bed, one of said transversely disposed die blocks being also transversely movable relative to the other, a ram engaging an endmost die block of each series for moving the die blocks of each series into contact with each other and against the end wall, and means for moving said transversely movable die block relative to the other transversely disposed die block, longitudinal rods slidably located through each series of dies, spaced shoulders upon said longitudinal rods, and means operatively connecting said longitudinal rods with said ram for separating the die blocks upon reverse movement of the ram.

3. Dies for forging a crankshaft comprising a stationary bed, longitudinal ribs at the longitudinal edges of said bed, a transversely disposed wall at one end of the bed, a series of normally separated die blocks independently longitudinally movable upon said bed between the ribs thereon, a vertically movable head above the bed, means for moving said head toward and from the bed, a series of normally separated, independently, longitudinally movable die blocks carried by the head and corresponding with the die blocks upon the bed to form cooperating pairs of upper and lower die blocks, at least one cooperating pair of said upper and lower die blocks having their meeting faces located in a plane vertically spaced from the horizontal plane in which the meeting faces of the remainder of said cooperating pairs of upper and lower die blocks are located, a pair of transversely disposed die blocks independently longitudinally movable upon the bed, one of said transversely disposed die blocks being also transversely movable relative to the other, a ram engaging an endmost die block of each series for moving the die blocks of each series into contact with each other and against the end wall, and means for moving said transversely movable die block relative to the other transversely disposed die block.

4. Dies for forging a crankshaft comprising a stationary bed, longitudinal ribs at the longitudinal edges of said bed, a transversely disposed wall at one end of the bed, a series of normally

separated die blocks independently longitudinally movable upon said bed between the ribs thereon, a vertically movable head above the bed, means for moving said head toward and from the bed, a series of normally separated, independently, longitudinally movable die blocks carried by the head and corresponding with the die blocks upon the bed to form cooperating pairs of upper and lower die blocks, at least one cooperating pair of said upper and lower die blocks having their meeting faces located in a plane vertically spaced from the horizontal plane in which the meeting faces of the remainder of said cooperating pairs of upper and lower die blocks are located, a pair of transversely disposed die blocks independently, longitudinally movable upon the bed, one of said transversely disposed die blocks being also transversely movable relative to the other, a ram engaging an endmost die block of each series for moving the die blocks of each series into contact

with each other and against the end wall, and means for moving said transversely movable die block relative to the other transversely disposed die block, longitudinal rods slidably located through each series of dies, spaced shoulders upon said longitudinal rods, and means operatively connecting said longitudinal rods with said ram for separating the die blocks upon reverse movement of the ram.

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