Feb. 7, 1961 G. H. APPEL 2,970,500

FORMING MACHINES

Filed Sept. 10, 1958 8 Sheets-Sheet 1

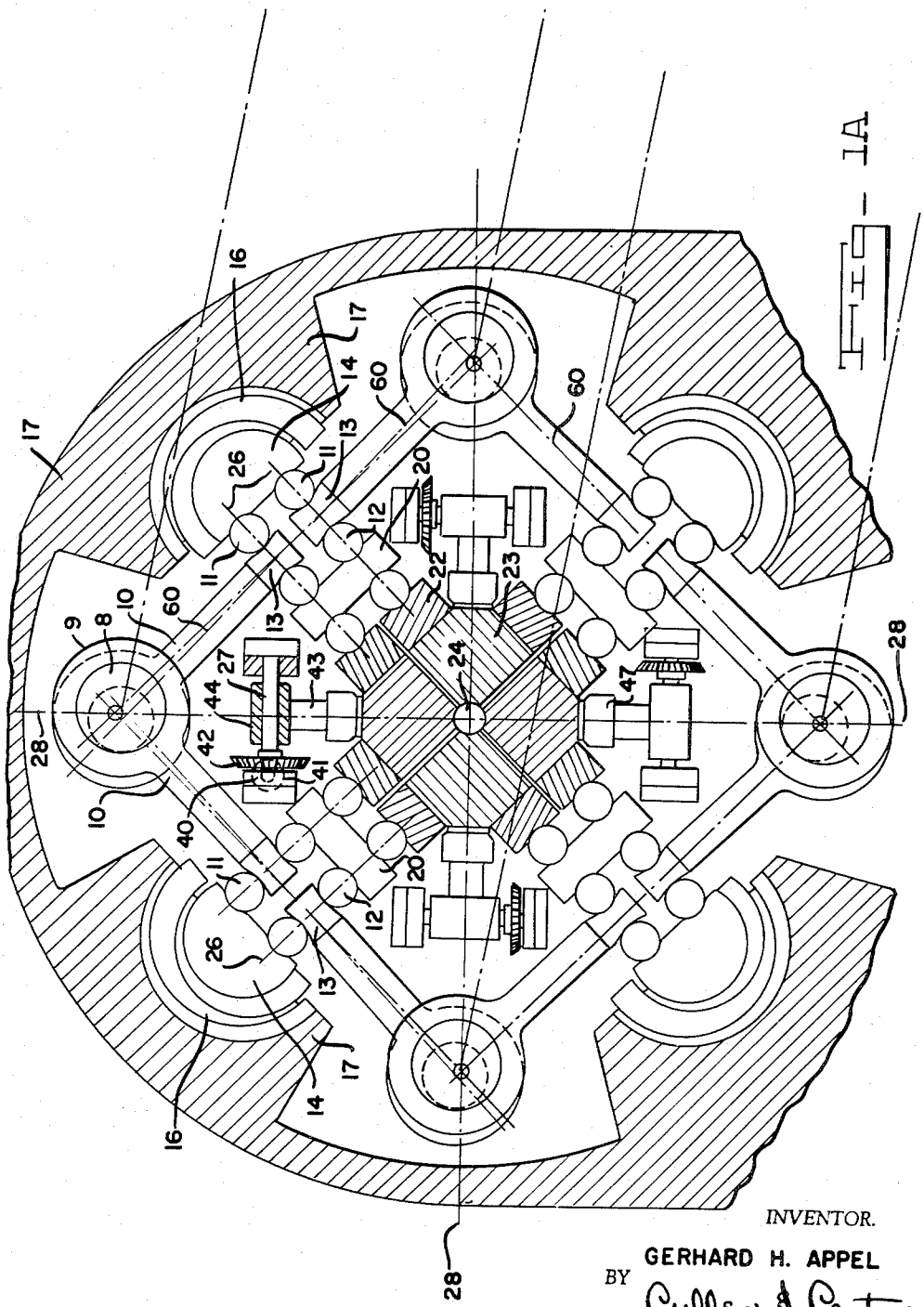


FIG. 1A

INVENTOR.
GERHARD H. APPEL
BY Cullen & Cantor
ATTORNEYS

Feb. 7, 1961 G. H. APPEL 2,970,500

FORMING MACHINES

Filed Sept. 10, 1958 8 Sheets-Sheet 2

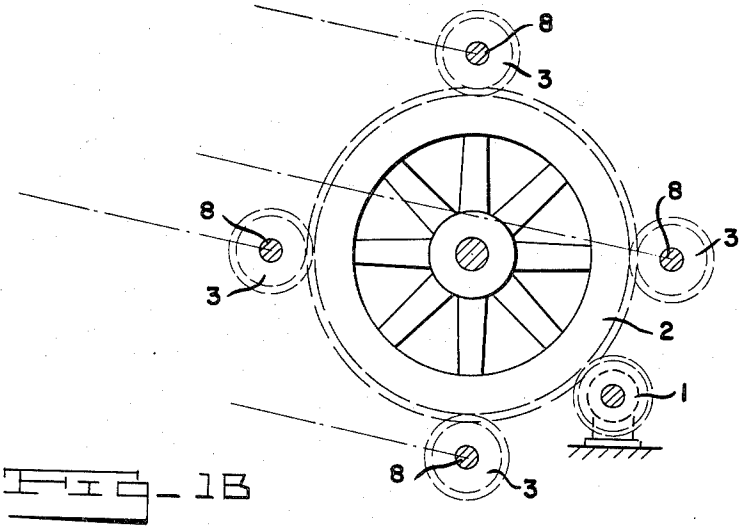


FIG-1B

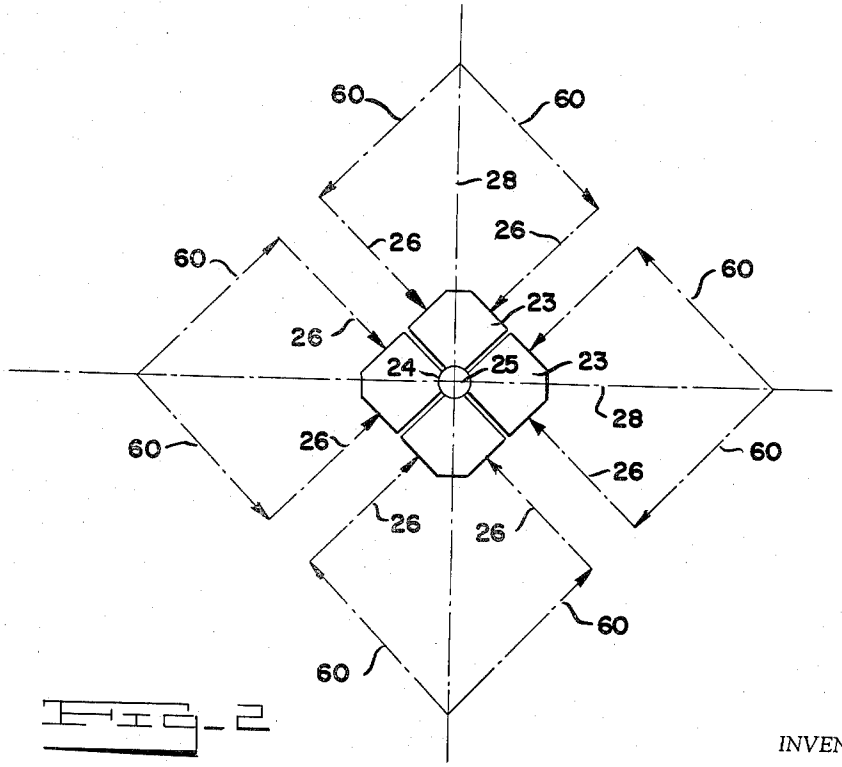


FIG-2

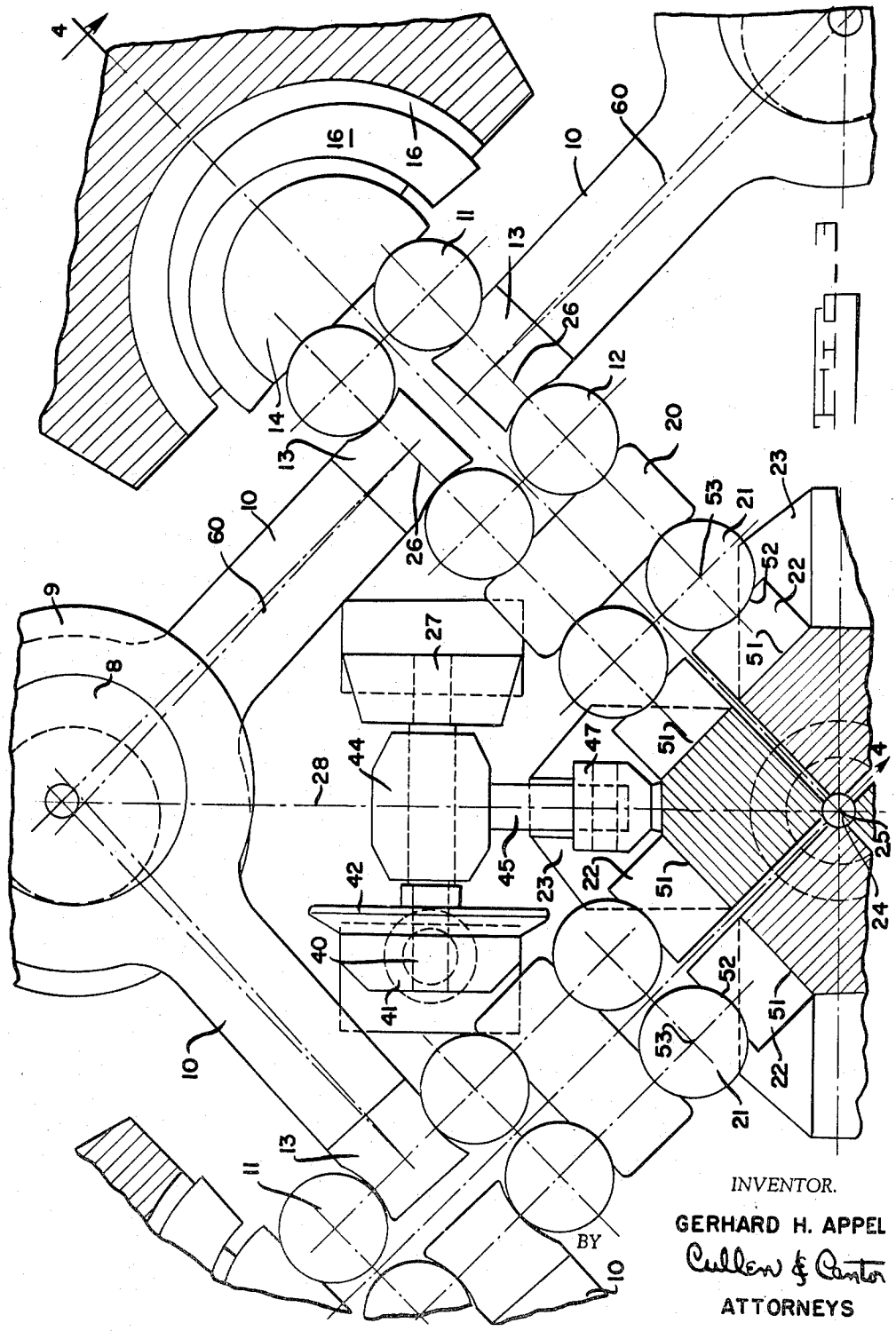
INVENTOR.
GERHARD H. APPEL

BY Cullen & Canton
ATTORNEYS

Feb. 7, 1961 G. H. APPEL 2,970,500

FORMING MACHINES

Filed Sept. 10, 1958 8 Sheets-Sheet 3



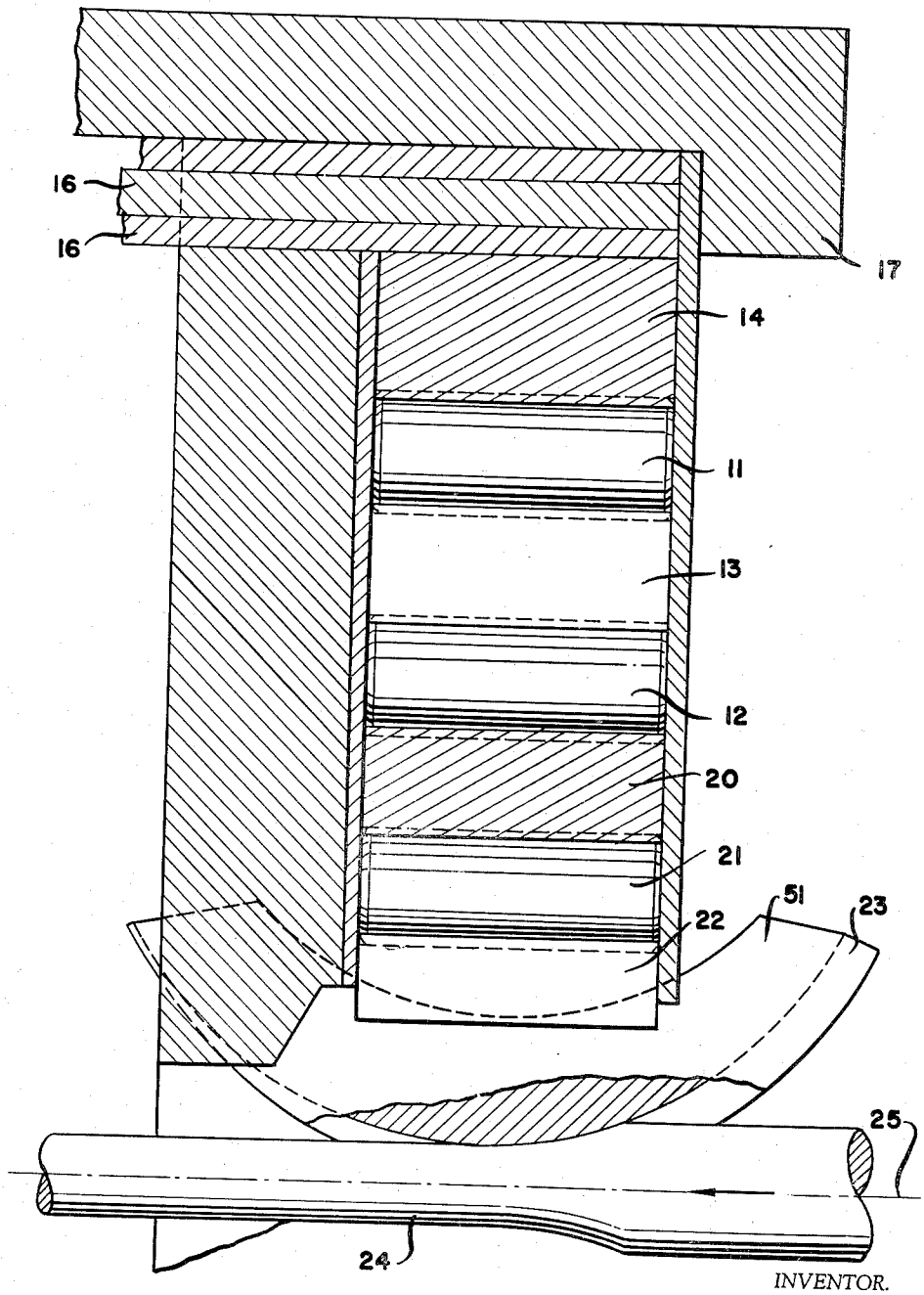
INVENTOR.
GERHARD H. APPEL
BY Cullen & Canton
ATTORNEYS

Feb. 7, 1961 G. H. APPEL 2,970,500

FORMING MACHINES

Filed Sept. 10, 1958

8 Sheets-Sheet 4



INVENTOR.

FIG. 4

BY GERHARD H. APPEL

Cullen & Cantor

ATTORNEYS

Feb. 7, 1961 G. H. APPEL 2,970,500

FORMING MACHINES

Filed Sept. 10, 1958 8 Sheets-Sheet 5

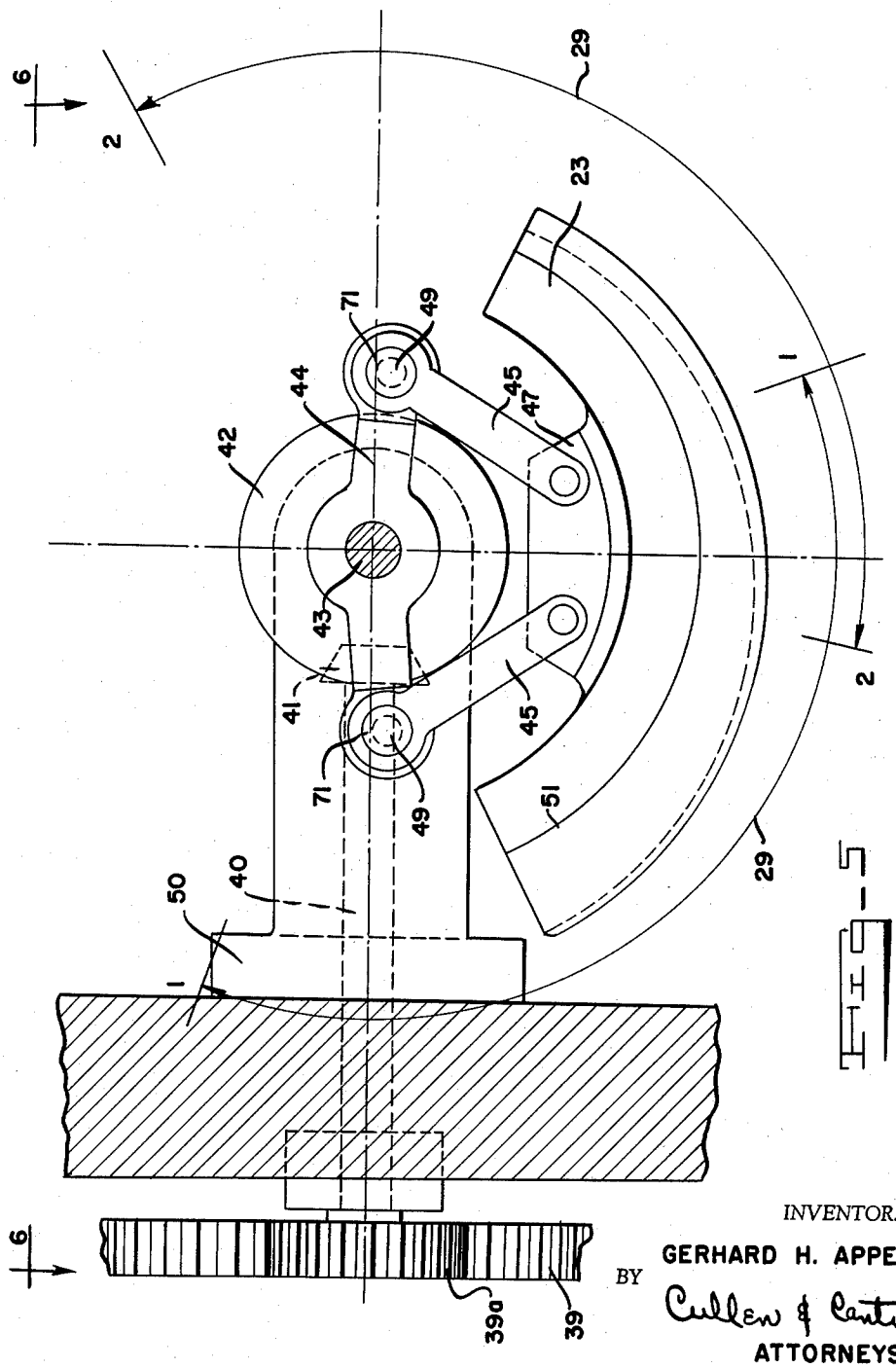


FIG. 5

INVENTOR.
GERHARD H. APPEL
BY Cullen & Canton
ATTORNEYS

Feb. 7, 1961 G. H. APPEL 2,970,500

FORMING MACHINES

Filed Sept. 10, 1958 8 Sheets-Sheet 6

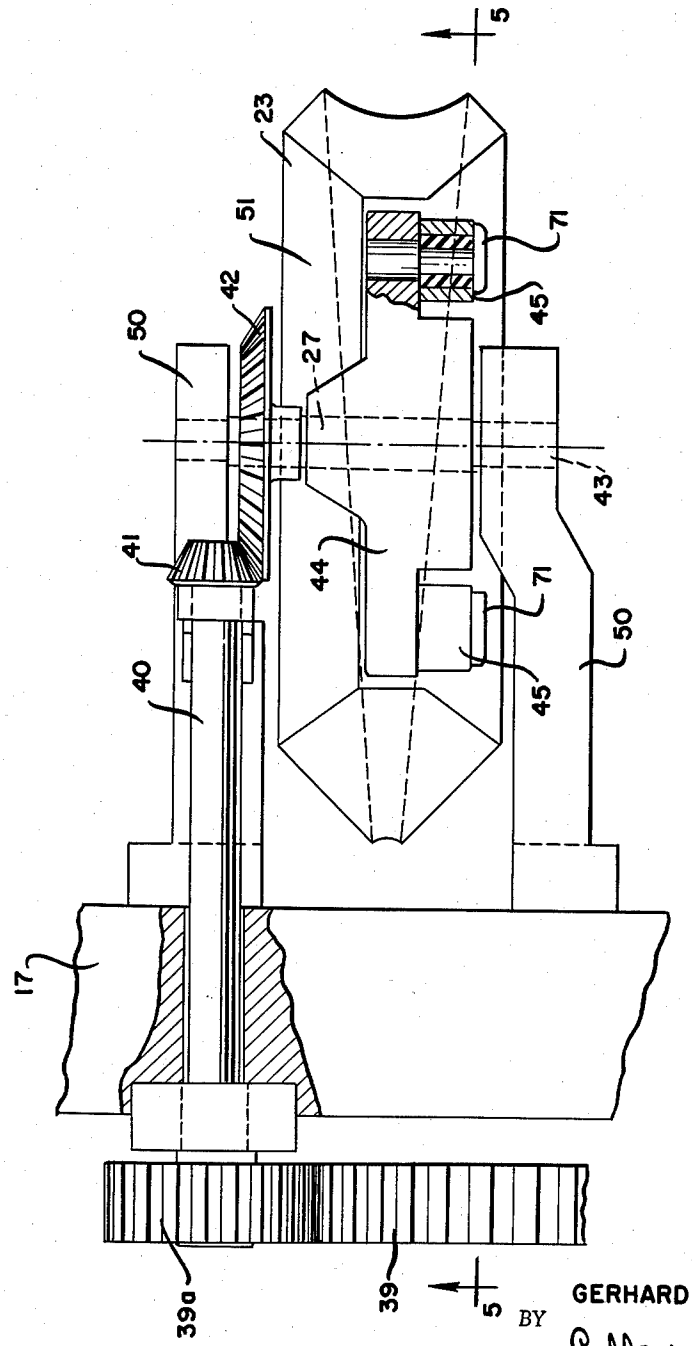


FIG. 6

INVENTOR.
GERHARD H. APPEL
BY Cullen & Canton
ATTORNEYS

Feb. 7, 1961 G. H. APPEL 2,970,500

FORMING MACHINES

Filed Sept. 10, 1958 8 Sheets-Sheet 7

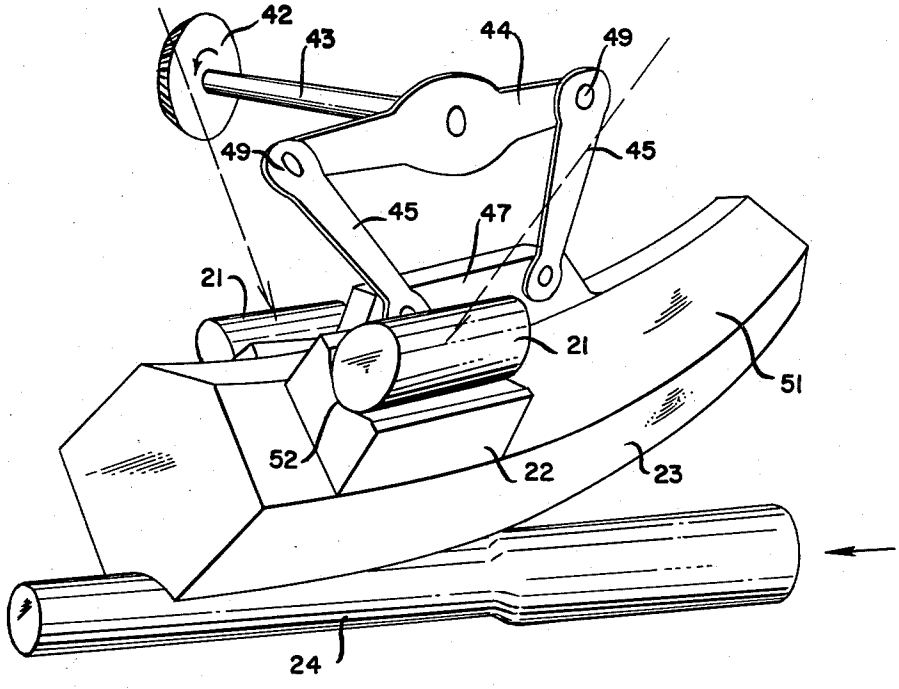


FIG. 7

INVENTOR.
GERHARD H. APPEL
BY
Cullen & Canton
ATTORNEYS

Feb. 7, 1961 G. H. APPEL 2,970,500

FORMING MACHINES

Filed Sept. 10, 1958 8 Sheets-Sheet 8

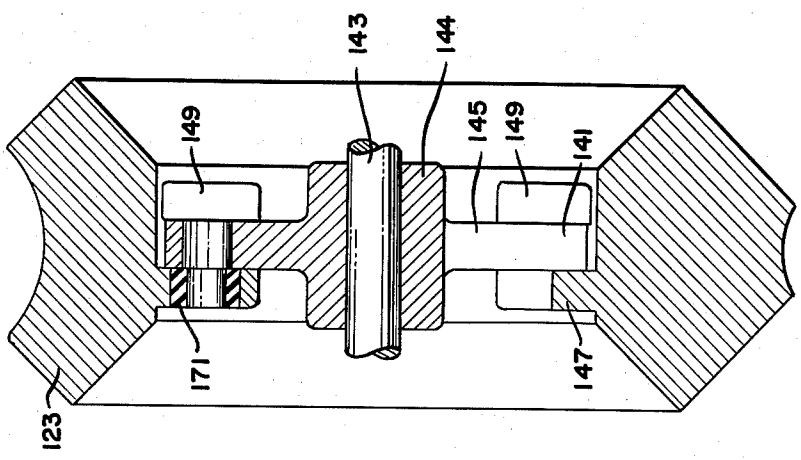


FIG. 9

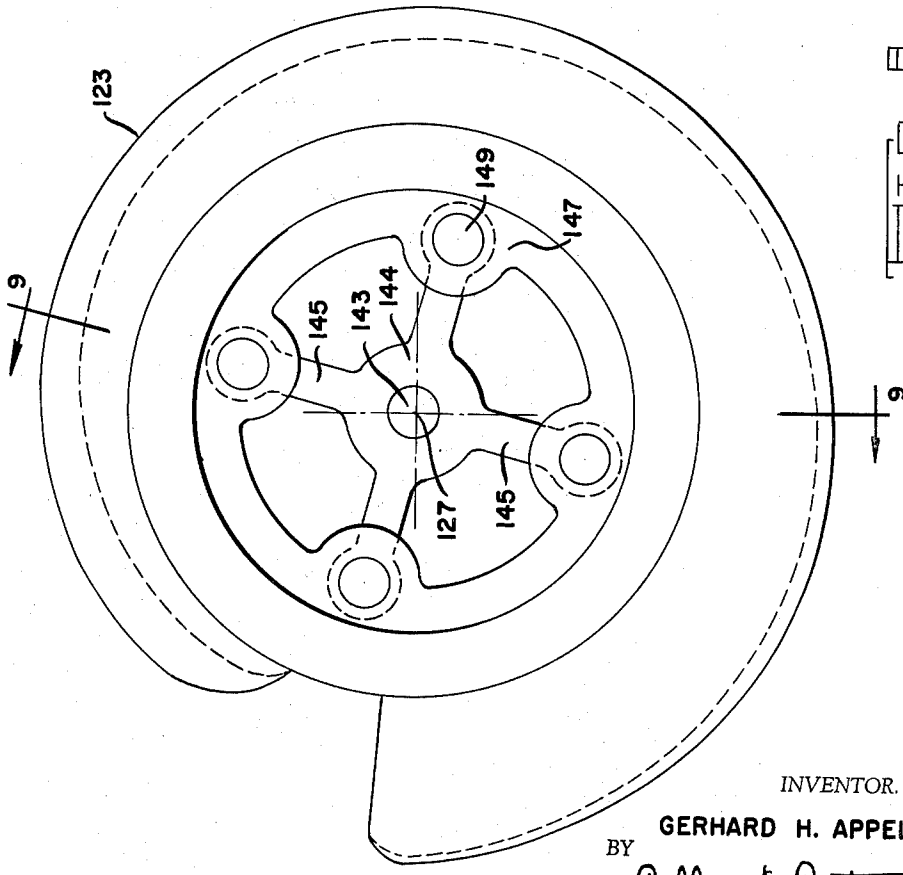


FIG. 8

INVENTOR.
GERHARD H. APPEL
BY
Cullen & Canton
ATTORNEYS

United States Patent Office 2,970,500 Patented Feb. 7, 1961

2,970,500

FORMING MACHINES

Gerhard H. Appel, Belle River, Ontario, Canada, assignor to Appel Process, Ltd., Oshawa, Ontario, Canada

Filed Sept. 10, 1958, Ser. No. 760,268

8 Claims. (Cl. 78—22)

This application relates to forming machines and particularly to forming machines generally of the character disclosed in a prior application of mine, Ser. No. 450,500 of the United States, filed August 17, 1954, now abandoned whose disclosure is incorporated hereinto by reference.

One specific object of the present invention is to provide a forming machine generally according to the character disclosed in the said application but characterized by the fact that the dies and die axes are arranged between the radial axes of the die movers rather than along such radial axes whereby the force on each die is not merely the force of one die mover but rather is a resultant of the forces of two die movers between which is the die. Thus, each die mover engages two dies, and each die is engaged by two die movers. In this way, a greater degree of accuracy of movement of the die along a radial axis transverse to the workpiece feeding axis is assured because the die is engaged by two die movers on opposite sides of the radial axis of the die itself.

Inasmuch as the die mover axes converge upon bevelled edges of the dies, towards the center, the two forces on a die from two die movers, converge, and this results in the forces being towards each other, a desired result.

A further object is to provide a construction wherein the radial axis of the die is between and preferably midway between the radial axes of two die movers, with the further improvement and object being that each die mover engages parts of two different dies whereby the force from each die mover is distributed equally over two dies and whereby each die receives its force from two die movers.

A still further object of the present invention is to provide in a machine of the general character disclosed in the said application, a construction wherein the dies are adjustable along the workpiece feeding axis whereby they may be adjusted to present different portions of their faces to the workpiece and to the die throat defined by the dies as the dies are adjusted along the workpiece feeding axis.

The dies are formed as rotors; they may be formed as rotary eccentrics with their throat defining workpiece engaging faces of varying contour, i.e., of varying distance from their axes of rotation, with respect to the workpiece feeding axis. Thus, these faces together define throats of varying form as the dies are rotated or adjusted along the workpiece feeding axis. In this way, by rotating or adjusting all the dies simultaneously and similarly, the throat forms may be varied and thus the external contour of the workpiece being fed along the feeding axis may be varied.

The dies could be formed as rotors with varying configurations such as for example, stepped surfaces, to produce workpieces with diameters varying by steps.

The dies can be formed as concentric rotors rather than as eccentrics, that is to say, their circumference will be concentric with their axis of rotation.

When the dies are formed as rotary eccentrics they are mounted to rotate about axes transverse to the radial

axis on which they move in their forming strokes and transverse to the workpiece axis. By rotation of the dies, these already being defined as rotary eccentrics, and as having working faces of varying contour, different forms of die throats are formed as the workpiece is fed along these feeding axes.

Each die is elongated, i.e., it is of such a length, measured along the workpiece axis, that it comprises many increments of work-engaging areas. Thus, by moving the die, different work-engaging areas may be successively presented to the work. With the die so constructed that the successively different work-engaging area increments are of different distances from the workpiece axis, so adjusting or moving the die varies its effective distance, at given moments, from the workpiece axis. Since there are several such dies, so moving them simultaneously varies the throat diameter. To obtain such variation by so moving or adjusting the dies is one object of the present invention.

In the specific embodiment disclosed, the dies are formed as rotary eccentrics and adjustment is obtained by rotation of the dies simultaneously to present different portions of the die faces to the work.

For an understanding of the embodiment of the invention disclosed herein, and for a better understanding of the matter in which the foregoing and other inherent objects are attained, reference should be had to the appended drawings and to the following specification which relates to them.

In these drawings:

Fig. 1 (1A and 1B) is an end view, to reduced scale, showing a complete machine.

Fig. 2 illustrates the geometry of the machine.

Fig. 3 is a partial end view, with parts in section.

Fig. 4 is a section on line 4—4 of Fig. 3.

Fig. 5 is a section view on line 5—5 of Fig. 6.

Fig. 6 is a section view on line 6—6 of Fig. 5.

Fig. 7 is a perspective view of a die and the means for rotating it.

Fig. 8 shows a modified form of die in side view.

Fig. 9 is a section on line 9—9 of Fig. 8.

Fig. 1B shows a motor 1 which drives a ring gear 2 meshing with pinions 3 of four equally spaced eccentric shafts 8 (Fig. 1A) within eight eccentrics 9 of eight driver rods 10. These have cams 13 which operate, through eight rollers 11 and eight rollers 12 and four backing plates 14 and eight adjustable arcuate wedges 16 in housing 17 on four intermediate blocks 20. These operate through eight rollers 21, on eight inserts 22 seated in four rotary eccentric or spiral dies 23 arranged around the workpiece 24 whose axis is at 25.

Parts 11—22 comprise die movers whose axes of movement are shown at 26, there being eight such axes for the four dies 23. (See Fig. 2.)

Two types of motion must be given to each spiral die 23. The first is positioning this die, while it is retracted from axis 25, by incrementally rocking it clockwise or counterclockwise around axis 27 transverse of the workpiece axis 25. The second is to move it along axis 28 transverse of the axes 27 and 28 towards or away from the workpiece axis 25 in working strokes which take place between the rocking or positioning strokes of the die.

Each of the four die axes 28 is midway between two die mover axes 26.

The increments of rocking of the spiral die for positioning cumulate to about 130° in the case of the die of Figs. 1–7, and up to 315° in the case of the die of Figs. 8–9 later to be explained. The total arc of rocking is indicated by the arcuate lines 29 shown twice on Fig. 5 and extending from position 1—1 to position 2—2.

The other motions of each die 23 are the forming strokes. These occur in off-beat relation to the first or

rocking strokes. The forming strokes are only about three thousandths of an inch and are advances of the dies along axes 28 towards axis 25, in response to movements of the die mover parts along axes 26 in response to movements of the drivers 10 along axes 60.

Die positioning parts

A ring gear 39 (Fig. 5) of the machine, through gears 39*a*, rotates each of four shafts 40, each having a bevel gear 41 cooperating with a bevel gear 42 on the end of a shaft 43. The parts thus rotate shafts 43 on axes 27. Each of these shafts carries and is connected to a rocker arm 44 (Fig. 7) connected by pins 49 to links 45 in turn connected to a block 47 integral with die 23. Each shaft 43 at its ends is journalled in stationary brackets 50 and the latter supports the parts just mentioned.

Block 47 is shown as integral with die 23. It could be separate from it in which case it would be splined to die 23; or it could be formed with external gear teeth meshing with internal gear teeth on die 23.

The rocking or positioning motion for each die 23, is only for incrementally rocking and thus positioning each of the dies 23, and the rocking strokes of dies 23 take place only between the working strokes of these dies and is without load.

Working stroke parts

The working stroke is simply a matter of moving each spiral die 23, while it is at rest, about .003 inch along axis 28, in whatever position it has assumed and been given by the positioning parts 39—50.

The driving force on each spiral die for a working stroke is obtained from one eccentric shaft 8 along two driver axes 60, which are 90° apart, from two drivers 10 acting through the cams 13, the rollers 12, the blocks 20, the rollers 21, and the inserts 22, which move on axes 26. Thus, each spiral die 23 while at rest is moved by being subjected to the converging force of two drivers 10 operating on axes 60 from the same eccentric shaft 8 but not operating through the same set of cams and rollers (10—11—12—13—14—20—21—22), etc. Thus, each spiral die is operated upon by the parts (10—22) associated with one eccentric shaft but with two different sets of parts (10—22) at 90° to each other.

It is to be noted that the dies are constantly in contact with the work. The die travel is .003 inch radially on axes 28 and they can shift on their 45° axes 26 a maximum of about .0015 inch. This amount of shifting is tolerable in this machine.

An important feature of this machine is the fact that each die is subjected to compressive or converging forces at 90°, on axes 26, opposed to each other but directed towards each other and towards the workpiece axis. These forces come from the drivers and cams, etc. (10—22), and thus each die instead of being subjected to diverging forces which tend to spread it apart is subjected to converging forces. Hence, it is important to note that each die is subjected to converging forces 90° opposed but directed towards each other and the center of the die.

Inasmuch as there are four dies operated simultaneously, it becomes necessary to provide for an adjustment for the die effects.

Thus, for example, if it turns out that one spiral die 23 is slightly off with respect to another die 23, instead of adjusting these two dies with respect to each other, it is merely necessary to adjust the working parts (11—22) for any one or more dies 23 and this adjustment is obtained by adjusting the curved wedges 16 as described more in detail in my prior patent application Ser. No. 604,372 of August 17, 1956. Thus, the operation of each die may be adjusted by means of these adjusting wedges 16 by adjusting the effect of each die on the workpiece, not by adjusting the position of that die itself but by adjusting the position of the working parts (11—22) which work on that die, and the final effect is still obtained but without the necessity for touching the dies themselves.

Each insert 22, of which there are eight for the four spiral dies 23, is seated (Fig. 3) on an arcuate shoulder 51 of the spiral die 23, to form a bevelled edge for the die. However, the insert is only about as long as the roller 21, and this in turn is considerably shorter than the total arcuate length of the spiral die. The insert 22 has a shallow arcuate groove 52 which seats the roller 21. This roller rotates in such seat 52 on its own axis 53, a matter of a very few degrees or so, and only during the working stroke of the parts. The roller 21 seats in the grooved seat 52 of the insert 22 which in turn seats on a shoulder 51 of the spiral die 23, and there is relative rotary motion at 52 between the roller 21 and the insert 22 in the spiral die 23 under load, i.e., during the working stroke.

There is, of course, considerable relative motion along the surface 51 between the spiral die 23 and the insert 22 during the positioning strokes of the spiral die, but this is not under load.

Such relative motion of insert 22 and die 23 occurs only during the positioning of the spiral die, for the insert 22 at all times remains with the roller 21, whereas the spiral die 23 moves relative to insert 22 in increments a total of 130°, in the case of the die of Figs. 1–7.

Lost motion

The spiral dies 23 move during the working strokes while the positioning parts 39, 40, 41, 42, 44, etc., are at rest. Hence, lost motion is provided between die 23 and the positioning parts to permit the required three-thousandths or so inch travel of the spiral die 23 with respect to the then stationary bracket 50 and shaft 43 on axis 27, and this is obtained by the use of rubber bushings 71 (Fig. 5) around the pins 49 which connect links 45 to rocker 44. These bushings 71, together with the elastic deformation of the links 45, rocker 44 and the joints provided by pins 49, will enable the spiral die 23 to move three-thousandths of an inch or so with respect to the shaft 43 and bracket 50 during the working stroke of the dies, as for example, when the dies 23 are moved by the inserts 22 responsive to the action on these inserts of the rollers 21, the intermediate blocks 20, the rollers 12, the cams 13, the drivers 10, the eccentrics 9, and the eccentric shafts 8.

Modification

Figs. 8–9 show a die 123 formed to act through a distance of about 315° rather than 135°, as in the case of the die of Figs. 1–7.

The die 123 is formed to rotate around axis 127 and is rotated by the following parts. A ring gear 39 (not shown), but corresponding to gear 39 of Figs. 5, 6 rotates a shaft 143 fixed to a cross 144 whose spokes 145 are connected by pins 149 in rubber bushings 171 inside holes of a ring 147 integral with die 123. Parts 123—147 may be separately formed and splined or gear meshed to each other. Rotation of the four shafts 143 simultaneously causes rotation and adjustment of all four dies 123 for varying the throat diameter.

Conclusion

Now having described the machine herein disclosed, reference should be had to the following claims.

I claim:

1. In a forming machine having means for feeding an elongated workpiece longitudinally along the workpiece axis; at least three dies spaced equally around and equally distant from the workpiece axis with each die having an inner face formed as the working face and having two angularly related outer faces opposing the working face; with these outer faces of each die being at angles of not over 120° to each other and with ad-

jacent outer faces of adjacent dies being co-planar; the dies being movable on radial die axes towards and away from the workpiece axes; die movers equal in number to the dies and outside of them and spaced equally around and equally distant from the workpiece axis but further away from the workpiece axis than the dies, and movable on radial die mover axes towards and away from the workpiece axis; the die axes being midway between the die mover axes and the die mover axes being midway between the die axes; each die mover being wide enough to straddle and simultaneously engage and move the co-planar adjacent outer faces of two adjacent dies; and each die being wide enough to straddle and be engaged by and moved simultaneously by two die movers on its two outer faces; and means for simultaneously moving all die movers and dies radially on their axes.

2. In a forming machine having means for feeding a workpiece longitudinally along a workpiece axis; at least three dies spaced equally around and equally distant from the workpiece axis with each having an inner face formed as a working face; the several working faces defining a die throat; the dies being radially movable simultaneously under equal and simultaneously applied radial loads in working strokes on radial die axes towards and away from the workpiece axis; means for simultaneously moving and loading all dies radially inwardly and outwardly along the die axes in working strokes; with each die having its working face of varying contour measured radially from the workpiece axis and mounted to be oscillatable for adjustment along the workpiece axis to aline different portions of the working face of that die with the die axis of that die; and means for oscillating and thus adjusting all the dies along the workpiece axis simultaneously and equally to constrict or enlarge the die throat.

3. A construction according to claim 2 wherein each die is an eccentric segment and is mounted for adjustment to rotate around a die adjusting axis transverse of the die axis and of the workpiece axis and wherein the means for adjusting the dies comprises means for rotating the dies on their die adjusting axes.

4. A construction according to claim 1 wherein each die has its working face of varying contour measured radially from the workpiece axis and mounted to be oscillatable for adjustment along the workpiece axis to aline different portions of the working face of that die with the die axis of that die; and means for oscillating and thus adjusting all the dies along the workpiece axis simultaneously and equally to constrict or enlarge the die throat.

5. A forming machine having at least three dies arranged radially about a central axis, each die having two associated die mover means arranged radially around such central axis but arranged outwardly of the die, each die being out of radial alinement with the two associated die mover means but rather midway between them, with each die being engaged by two associated die mover means simultaneously; with each die mover means being arranged to engage parts of two dies; each die being adjustable along the central axis to present different portions of their faces to that axis, the dies having their axis facing faces of varying contour with respect to that axis and means for adjusting all the dies simultaneously and similarly; each die for adjustment being mounted to rotate around a die adjusting axis transverse of the central axis; the means for adjusting the dies comprising means for rotating the dies on these die adjusting axes of rotation; each die mover means engaging parts of two dies simultaneously; each die being a segment of an eccentric having spokes meeting in a hub which mounts it for rotation and having two beveled edges each engaged by a die mover.

6. A forming machine having a central axis along

which an elongated workpiece may be fed; four identical dies arranged in a working plane, which is normal to the central axis, and spaced equally around the axis and spaced equidistantly from the axis to form a die throat; each of the dies having an inner working face which defines a portion of the die throat and an outer face opposing the working face, the two side edges of each of the outer faces being bevelled at equal but opposite angles relative to that axis of the die which is radial to the central axis and the dies being movable towards and away from the central axis to thus constrict and enlarge the die throat; four identical die movers arranged in the plane of the dies and equally spaced around the central axis but located further from the central axis than are the dies, each die mover being movable only towards and away from the central axis along a die mover axis which is radial to the central axis and is located midway between the radial axes of two adjacent dies so that the axis of movement of each die mover is located between two radial die axes; each die mover having an inner end arranged in contact with two adjacent bevelled side edges of two adjacent dies so that each die mover contacts two separate dies and each die is contacted by two separate die movers, and means for simultaneously moving all the die movers along their respective axis of movement towards and away from the central axis for pushing the dies towards the central axis.

7. A construction as defined in claim 6 and each of the die working faces being elongated and identically curved in a plane containing the central axis, that is, in a plane which is normal to said working plane in which the dies are moved towards and away from the central axis, and means for simultaneously moving all the dies in a direction transverse to the working plane for constricting and enlarging the die throat in addition to changes in the die throat due to movement of the dies under influence of the die movers.

8. A construction as defined in claim 6 and wherein each of the dies is elongated and is equally curved away from the central axis in the direction of the central axis and wherein the die movers engage that part of the die which is located in said working plane, and means supporting and interconnecting the dies and for simultaneously and equally moving all the dies in the direction of the central axis when the die movers are moved away from the central axis for changing the part of the die working face which is in the working plane and which is engaged by the die movers; and lost motion means connecting the dies to the means for supporting and interconnecting the dies wherein the dies are normally held against movement in the direction of the central axis but are normally movable towards and away from the central axis in a radial direction.

References Cited in the file of this patent

UNITED STATES PATENTS

234,931	Thompson	Nov. 30, 1880
249,268	Thompson	Nov. 8, 1881
570,816	Price	Nov. 3, 1896
647,201	Rowley	Apr. 10, 1900
773,197	Crawshaw	Oct. 25, 1904
952,298	Berg	Mar. 15, 1910
2,247,863	Tiedemann	July 1, 1941
2,301,093	Tiedemann	Nov. 3, 1942
2,863,342	Appel	Dec. 9, 1958

FOREIGN PATENTS

724,515	France	Jan. 29, 1932
49,937	France	June 6, 1939
721,769	Great Britain	Jan. 12, 1955
3420Ib	Germany	Mar. 22, 1956
934,137	Germany	Sept. 9, 1954