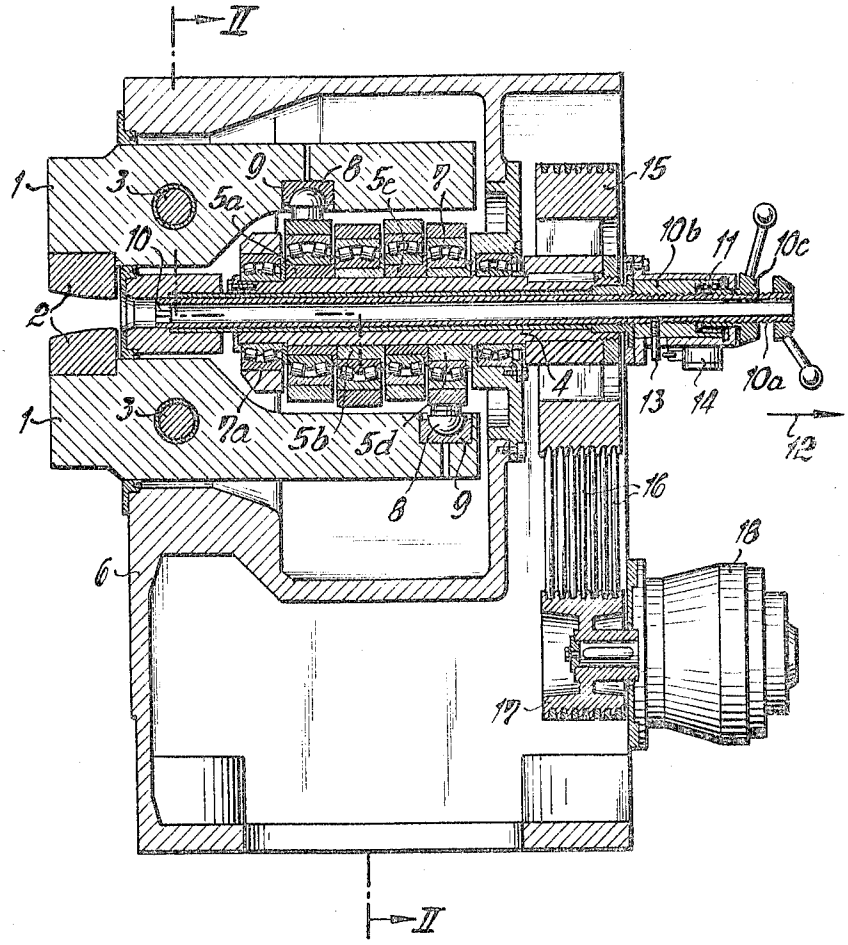
Aug. 2, 1966 H. BRAUER ET AL 3,263,478

FORGING MACHINES

Filed Oct. 9, 1963 2 Sheets-Sheet 1

FIG. 1



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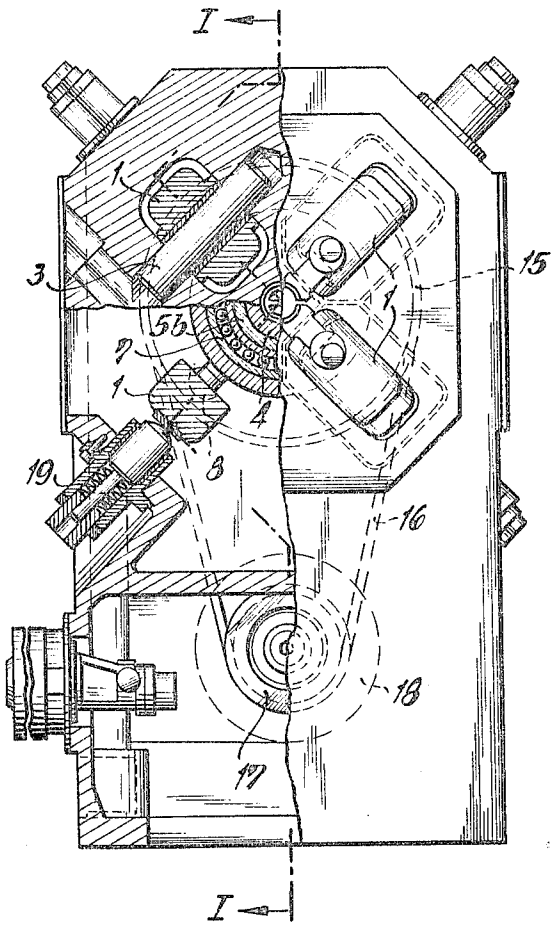
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FIG. 2



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FORGING MACHINES

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10 Claims. (Cl. 72—402)

The present invention relates to forging machines.

More particularly, the present invention relates to forging machines which include more than a pair of tools for engaging the work.

Forging machines which are provided with more than a pair of tools for engaging the work have serious drawbacks. In the first place, they are exceedingly complex and costly requiring independent drives for the independent tool-supporting structures. In the second place the adjusting structure as well as other structure of the forging machines are arranged so that a considerable amount of scale separated from the work during the forging operations falls on the adjusting structure and other structure in an undesirable manner. Also, the adjusting structure itself is not always easily accessible.

It is accordingly a primary object of the present invention to provide a forging machine which will avoid the above drawbacks.

Thus, it is an object of the present invention to provide an exceedingly simple forging machine in which more than two tool-carrying levers can be driven without the use of any particularly complex structures.

It is also an object of the present invention to provide a structure of the above type which makes it relatively simple to operate a plurality of tool-carriers either in pairs or all simlutaneously.

In addition it is an object of the present invention to provide a structure of the above type wherein the adjusting means of the machine is easily accessible and at the same time protected from any falling scale or the like.

Furthermore, it is an object of the present invention to provide for a structure of the above type an arangement where the drives and transmissions not only to a main shaft but also to all of the tool-carrying structures are all protected from falling scale and the like.

With these objects in view the invention includes, in a forging machine, a support means which supports for rotary movement an elongated rotary shaft means. A plurality of elongated lever means are adapted to carry tools, respectively, and these lever means are distributed about the elongated shaft means and extend in the same general direction as the elongated shaft means, the latter extending in the same direction as the work. A plurality of pivot means are respectively carried by the support means and respectively support the plurality of lever means for turning movement respectively about a plurality of axes which are perpendicular to the axis of the rotary shaft means, and an actuating means is located between and cooperates with the rotary shaft means and the plurality of lever means for actuating the latter to turn respectively about said plurality of pivot means in response to rotation of said rotary shaft means.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings, in which:

FIG. 1 is a sectional elevation of a forging machine

according to the invention, the section of FIG. 1 being taken along line I—I of FIG. 2 in the direction of the arrows; and

FIG. 2 is a partly sectional front view of the machine of FIG. 1 taken along line II—II of FIG. 1 in the direction of the arrows.

Referring now to the drawings, it will be seen that the tools **2** are respectively carried by a plurality of lever means **1** each of which is in the form of a two-armed lever. In the illustrated example there are four lever means **1**. A pivot means **3** supports each lever **1** intermediate its ends for turning movement. A rotary shaft means is supported for rotation by the support means **6** which forms the frame of the machine, and it will be noted that the several pivot means **3** are located in a common plane which is normal to the axis of the rotary shaft means **4** and in addition each pivot means **3** extends perpendicularly with respect to the rotary shaft means **4**, this rotary shaft means itself extending in the same direction as the work.

Thus, as may be seen particularly from FIG. **1**, the frame **6** has a hollow interior portion and has a front wall formed with an opening passing therethrough and communicating with the hollow interior portion, and only the free left end portions of levers **1**, as viewed in FIG. 1, extend outwardly beyond the frame **6**, while the elongated inner end portions of the levers **1**, located in FIG. 1 to the right of the common plane in which the plurality of pivot means **3** are located, are located in the hollow interior of the frame **6**, and these levers **1** are uniformly distributed about the rotary drive shaft means **4**, as is particularly apparent from FIG. 2.

Within the frame **6** to the right of the pivots **3**, as viewed in FIG. 1, is located an actuating means which is operatively connected to the rotary shaft means **4** and the several levers **1** for actuating the latter in response to rotation of the roary shaft means **4**. This actuating means includes a plurality of eccentric rings which surround and are fixed to the shaft **4** for rotation therewith, and the number of eccentric rings equals the number of levers **1**, so that in the illustrated example where there are four levers **1** there are four eccentric rings **5***a*–**5***d*. The actuating means includes, in addition to the several eccentric rings **5***a*–**5***d*, a plurality of self-aligning roller bearings **7** which respectively surround the plurality of eccentric rings, and the several self-aligning bearings are respectively connected with the several levers **1** through the ball-and-socket joints **8**, **9**, which also form part of the actuating means. Thus, FIG. 1 shows the self-aligning bearing **7** which surrounds the eccentric ring **5***a* connected through a ball **8** and a socket **9** to the lever **1** which appears at the upper part of FIG. 1, while the self-aligning roller bearing **7** which surrounds the eccentric ring **5***d* of FIG. 1 is connected through an identical ball-and-socket joint to the lower lever **1** of FIG. 1, the balls **8** of the ball-and-socket joints being fixed to the bearings, respectively. FIG. 1 also shows a roller bearing **7***a* which forms one of the bearings which supports the rotary shaft means **4** for rotation.

The elongated rotary shaft means **4** is hollow and accommodates in its interior a stop **10** which is axially shiftable within the hollow shaft **4**, and a spring **11** urges the stop **10** to the left to the illustrated position shown in FIG. 1. During the forging process the workpiece is moved in the direction of the arrow **12** shown at the right of FIG. 1 and moves the stop **10** in opposition to the spring **11** also in the direction of the arrow **12**, and the stop assembly **10** carries a switch-actuating pin **13** which, when the assembly **10** moves in the direction of the arrow **12** actuates a limit switch **14** for an unillustrated drive which feeds the work so as to de-energize this drive or

reverse the direction in which the work is fed. The stop assembly **10** includes a threaded portion **10***a* at the right end, as viewed in FIG. 1, of an elongated hollow tube within the shaft **4** which terminates at its left end in the stop portion which is engaged by the work, and this threaded portion **10***a* is threaded into a sleeve **10***b* which is directly engaged by the spring **11**. A nut assembly **10***c* is also threadedly carried by the portion **10***a* of the stop assembly to determine the position of the stop assembly.

A drive means is operatively connected to the rotary shaft means **4** to rotate the latter, and this drive means is located at a portion of the rotary shaft means which is distant from the tools **2**, the drive means including a pulley **15** fixed to the rotary shaft means **4** and a plurality of belts **16** which pass around the pulley **15** as well as around a pulley **17** which is driven by the electric motor **18**.

If desired the stop assembly **10** may be used to actuate a pneumatic assembly which serves to blow compressed air in order to cool the tools during hot forging so as to cool the tools.

A plurality of spring means are carried by the support means **6** in order to urge the plurality of levers **1** at their inner portions toward the rotary shaft means **4**, and one of these spring means **19** is shown in FIG. 2 cooperating with the lower left lever **1** of FIG. 2. Thus, each spring means **19** includes a hollow cylinder in which a piston is slidable and a stack of springs act on the piston to urge the latter toward the lever **1**. In this way the sockets **9** are always maintained pressed against the balls **8** so that the several eccentric rings **5***a*–**5***d* are always in proper operative relationship with respect to the several levers **1** in order to control the positions thereof in response to rotary movement of the shaft means **4**.

As is shown at the upper left portion of FIG. 2, the support means **6** is formed with cutouts through which the levers **1** freely pass and supports each pivot pin **3** at its end portions each pivot pin extending across the cutout occupied by the lever **1** and through a bearing carried by the lever **1** so that in this way each lever **1** is supported for turning movement about the pivot means **3** which carries the latter.

As is apparent from FIG. 2, the several levers **1** are uniformly distributed about the shaft **4** and extend in the same general direction as the latter with the axis of the shaft **4** extending perpendicularly wtih respect to the common plane in which the several pivots **3** are located, and these pivots **3** are respectively located along the sides of an imaginary square in this plane with the axis of the shaft **4** passing through the center of this square.

As is particularly apparent from FIG. 1, any scale which falls from the work during engagement thereof by the tools **2** which are respectively carried by the levers **1** cannot possibly engage any part of the machine where the scale might be undesired. Thus, not only is the drive means **15**–**18** for the rotary shaft **4** distant from the tools **2**, but in addition the structure for adjusting the stop **10** is easily accessible at the rear of the machine also distant from the tools **2** and also the actuating means for turning the levers **1** in response to rotation of the shaft **4** is housed within the frame **6** away from a location where any scale might reach the eccentric rings, bearings **7**, or ball-and-socket joints **8**, **9**.

It will be noted that with the structure of the invention there is only a single rotary drive shaft which in an exceedingly simple manner transmits the drive to the several levers **1** which carry the tools **2**, there being four levers **1** in the illustrated example. The several eccentric rings are located one next to the other along the rotary shaft **4**, and in order to control the manner in which the levers **1** are turned it is only necessary to control the arrangement of the several eccentric rings **5***a*–**5***d* relative to each other. Thus, these eccentric rings, which may be identical, may be arranged so that they are all angularly aligned with respect to each other, and in this case all of the tools **2** would simultaneously move toward and away from the work in synchronism and in unison. If desired, however, the eccentric rings **5***a*–**5***d* may have with respect to each other an angular relationship which causes first one pair of opposed levers **1** to move their tools **2** toward the work and then the other pair of opposed levers **1** to move their tools **2** toward the work, or, if desired, it is a simple matter to angularly arrange the several eccentric cams so that the levers **1** are actuated in any desired sequence, so that the machine of the invention is not only simple but in addition it is extremely flexible and can be set to provide a wide variety of operations.

Moreover, it will be noted that with the structure of the invention there is always a series of bearings participating in the transmission of power from the drive shaft to the several tool-carrying levers, so that the machine operates in a quiet, smooth manner and there is but little wear of the adjusting structure.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of forging machines differing from the types described above.

While the invention has been illustrated and described as embodied in forging machines with more than two tools, it is not intended to be limited to the details shown, since various modification and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be secured by Letters Patent is:

1. In a forging machine, in combination, stationary support means; rotary drive shaft means supported for rotary movement by said support means in a position where the axis of said drive shaft means extends in the same direction as the work which is treated by the machine; a plurality of now-rotary tool-carrying lever means distributed about and extending in the same general direction as said rotary drive shaft means, the number of said stationary tool-carrying lever means extending two; a plurality of pivot means respectively supporting said plurality of lever means for tilting movement, said plurality of pivot means being respectively carried by said stationary support means and each of said pivot means extending perpendicularly with respect to said rotary shaft means; and actuating means extending between and cooperating with said rotary shaft means and said plurality of now-rotary lever means for actuating the latter.

2. In a forging machine, in combination, stationary support means; rotary drive shaft means supported for rotary movement by said support means in a position where the axis of said drive shaft means extends in the same direction as the work which is treated by the machine; a plurality of non-rotary tool-carrying lever means distributed about and extending in the same general direction as said rotary drive shaft means, the number of said stationary tool-carrying lever means exceeding two; a plurality of pivot means respectively supporting said plurality of lever means for tilting movement, said plurality of pivot means being respectively carried by said stationary support means and each of said pivot means extending perpendicularly with respect to said rotary shaft means; and actuating means extending between and cooperating with said rotary shaft means and said plurality of non-rotary lever means for actuating the latter, all of said pivot means respectively having their axes located

in a common plane which is normal to the axis of said rotary shaft means.

3. In a forging machine, in combination, stationary support means; rotary drive shaft means supported for rotary movement by said support means in a position where the axis of said drive shaft means extends in the same direction as the work which is treated by the machine; a plurality of non-rotary tool-carrying lever means distributed about and extending in the same general direction as said rotary drive shaft means, the number of said stationary tool-carrying lever means exceeding two; a plurality of pivot means respectively supporting said plurality of lever means for tilting movement, said plurality of pivot means being respectively carried by said stationary support means and each of said pivot means extending perpendicularly with respect to said rotary shaft means; and actuating means extending between and cooperating with said rotary shaft means and said plurality of non-rotary lever means for actuating the latter, said actuating means including a plurality of eccentric rings respectively surrounding and fixed to said rotary shaft means for rotary movement therewith and being equal in number to the number of said plurality of lever means, a plurality of self-aligning bearings respectively surrounding said plurality of eccentric rings, and a plurality of ball-and-socket joints respectively connecting said bearings with said plurality of lever means so that the latter are tilted with respect to said plurality of pivot means in a manner determined by the arrangement of the plurality of eccentric rings on said shaft means.

4. In a forging machine, in combination, stationary support means; rotary drive shaft means supported for rotary movement by said support means in a position where the axis of said drive shaft means extends in the same direction as the work which is treated by the machine; a plurality of non-rotary tool-carrying lever means distributed about and extending in the same general direction as said rotary drive shaft means, the number of said stationary tool-carrying lever means exceeding two; a plurality of pivot means respectively supporting said plurality of lever means for tilting movement, said plurality of pivot means being respectively carried by said stationary support means and each of said pivot means extending perpendicularly with respect to said rotary shaft means; actuating means extending between and cooperating with said rotary shaft means and said plurality of non-rotary lever means for actuating the latter, said actuating means including a plurality of eccentric rings respectively surrounding and fixed to said rotary shaft means for rotary movement therewith and being equal in number to the number of said plurality of lever means, a plurality of self-aligning bearings respectively surrounding said plurality of eccentric rings, and a plurality of ball-and-socket joints respectively connecting said bearings with said plurality of lever means so that the latter are tilted with respect to said plurality of pivot means in a manner determined by the arrangement of the plurality of eccentric rings on said shaft means; and a plurality of spring means carried by said support means and respectively urging said plurality of lever means at the portions thereof which are adjacent to said eccentric rings toward the latter.

5. In a forging machine, in combination, stationary support means; rotary drive shaft means supported for rotary movement by said support means in a position where the axis of said drive shaft means extends in the same direction as the work which is treated by the machine; a plurality of non-rotary tool-carrying lever means distributed about and extending in the same general direction as said rotary drive shaft means, the number of said stationary tool-carrying lever means exceeding two; a plurality of pivot means respectively supporting said plurality of lever means for tilting movement, said plurality of pivot means being respectively carried by said stationary support means and each of said pivot means extending perpendicularly with respect to said rotary shaft means; and actuating means extending between and cooperating with said rotary shaft means and said plurality of non-rotary lever means for actuating the latter, each of said lever means being in the form of a two-armed lever having on one side of its pivot means a free end portion adapted to carry a tool and on the other side of its pivot means an elongated portion which cooperates with said actuating means.

6. In a forging machine, in combination, a stationary frame having a hollow interior portion and having a front wall formed with an opening through which said hollow interior portion communicates with the exterior of said frame; rotary drive shaft means extending in the same direction as the work and supported for rotation by said frame with said rotary drive shaft means extending partly into said hollow interior of said frame; a plurality of two-armed non-rotary levers respectively extending in the same direction as said rotary drive shaft means and extending through said opening into the hollow interior of said frame, said levers having only free end portions extending outwardly beyond said frame and said free end portions being adapted to carry tools and the number of said levers exceeding two; a plurality of pivot means respectively located intermediate the ends of said plurality of levers and supporting the latter for tilting movement, said plurality of pivot means being carried by said stationary frame and said levers respectively having elongated inner portions extending inwardly beyond said plurality of pivot means; and actuating means located in the hollow interior of said frame and operatively connected to said rotary shaft means and said inner portions of said non-rotary levers for actuating the latter to tilt about said plurality of pivot means in response to rotation of said rotary shaft means.

7. In a forging machine, in combination, stationary support means; four elongated pivot pins carried by said support means in a common plane and respectively located along the sides of an imaginary square located in said plane; four elongated identical two-armed non-rotary levers respectively supported for tilting movement by said four pivot pins, said levers having portions located on one side of said plane and adapted to carry tools, respectively; elongated rotary shaft means supported for rotation by said stationary support means and having an axis which is normal to said plane and which extends through the center of said square, said shaft means being located almost entirely on the other side of said plane and said levers respectively having elongated portions on said other side of said plane uniformly distributed about said shaft means; and actuating means located on said other side of said plane and operatively connected to said rotary shaft means and said non-rotary levers for tilting the latter about said plurality of pivot pins in response to rotation of said rotary shaft means.

8. In a forging machine, in combination, stationary support means; four elongated pivot pins carried by said support means in a common plane and respectively located along the sides of an imaginary square located in said plane; four elongated identical two-armed non-rotary levers respectively supported for tilting movement by said four pivot pins, said levers having portions located on one side of said plane and adapted to carry tools, respectively; elongated rotary shaft means supported for rotation by said support means and having an axis which is normal to said plane and which extends through the center of said square, said shaft means being located almost entirely on the other side of said plane and said levers respectively having elongated portions on said other side of said plane uniformly distributed about said shaft means; and actuating means located on said other side of said plane and operatively connected to said rotary shaft means and said levers for tilting the latter about said plurality of pivot pins in response to rotation of said rotary shaft means, said actuating means including a plu-

rality of eccentric rings surrounding and fixed to said rotary shaft means for rotation therewith, a plurality of self-aligning bearings respectively surrounding said eccentric rings, and a plurality of ball-and-socket joints respectively connecting said bearings to said levers, so that according to the arrangement of said plurality of eccentric rings on said rotary shaft means the plurality of levers will be actuated in a predetermined manner.

9. In a forging machine, in combination, stationary support means; four elongated pivot pins carried by said support means in a common plane and respectively located along the sides of an imaginary square located in said plane; a plurality of elongated identical two-armed non-rotary levers respectively supported for tilting movement by said plurality of pivot pins, said levers having portions located on one side of said plane and adapted to carry tools, respectively, and the number of said levers exceeding two; elongated rotary shaft means supported for rotation by said support means and having an axis which is normal to said plane and which extends through the center of said square, said shaft means being located almost entirely on the other side of said plane and said levers respectively having elongated portions on said other side of said plane uniformly distributed about said shaft means; actuating means located on said other side of said plane and operatively connected to said rotary shaft means and said levers for tilting the latter about said plurality of pivot pins in response to rotation of said rotary shaft means; and drive means operatively connected to a portion of said rotary shaft means which is on said other side of said plane and located on the other side of said actuating means from said plane.

10. In a forging machine, in combination, stationary support means; rotary drive shaft means supported for rotary movement by said support means in a position where the axis of said drive shaft means extends in the same direction as the work which is treated by the machine; a plurality of non-rotary tool-carrying lever means distributed about and extending in the same general direaction as said rotary drive shaft means, the number of said stationary tool-carrying lever means exceeding two; a plurality of pivot means respectively supporting said plurality of lever means for tilting movement, said plurality of pivot means being respectively carried by said support means and each of said pivot means extending perpendicularly with respect to said rotary shaft means; actuating means extending between and cooperating with said rotary shaft means and said plurality of non-rotary lever means for actuating the latter; and drive means operatively connected to said rotary shaft means for rotating the latter and located distant from those portions of said lever means which carry the tools.

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