July 29, 1969 E. E. HAHN ET AL 3,457,779

CAM PLASTOMETER

Filed July 13, 1967 3 Sheets-Sheet 1

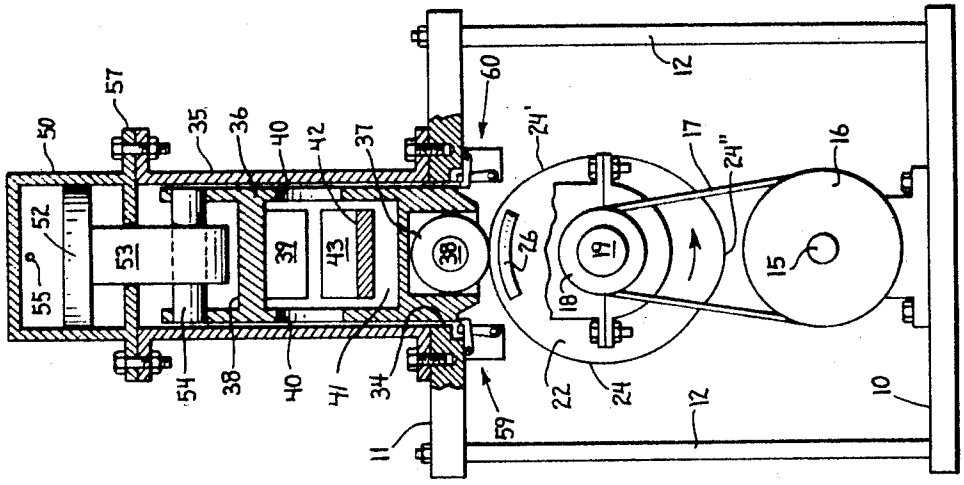

Fig. 2.

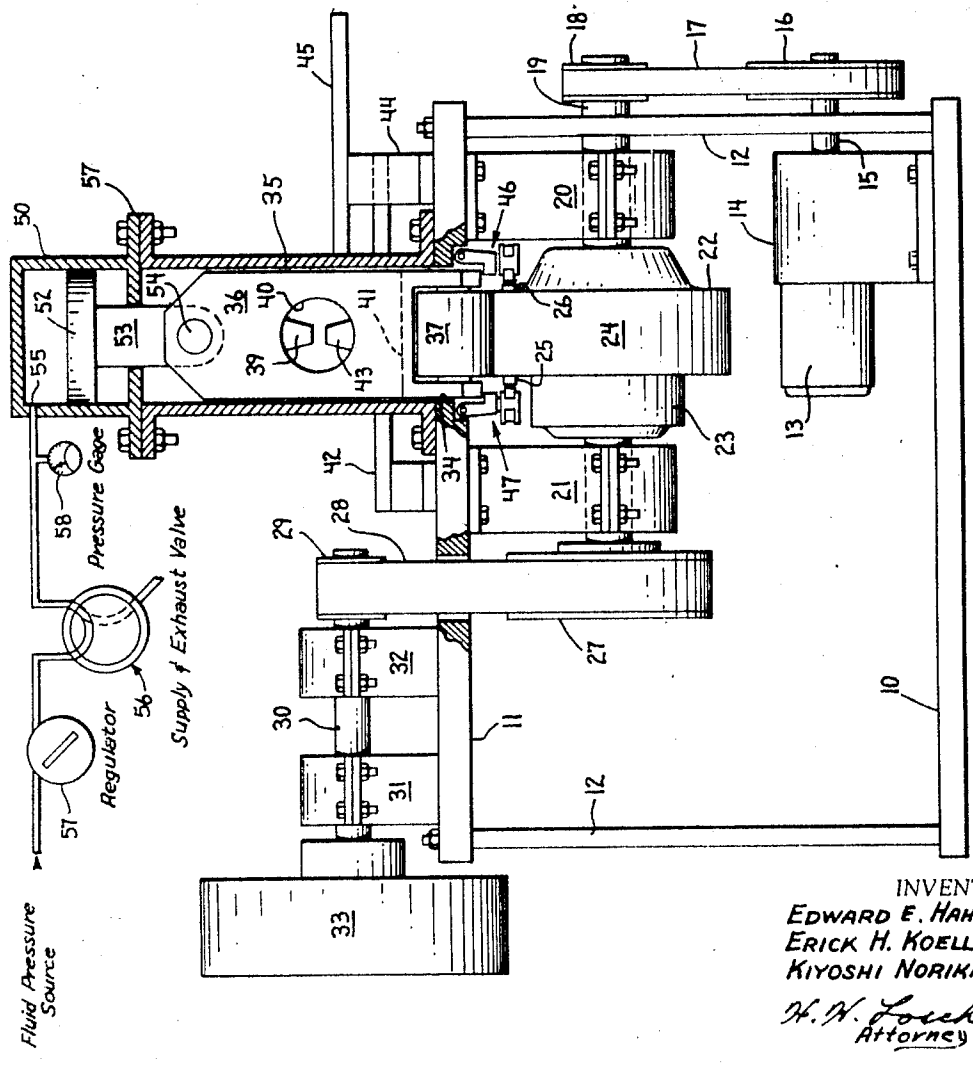

Fig. 1.

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CAM PLASTOMETER

Filed July 13, 1967 3 Sheets-Sheet 2

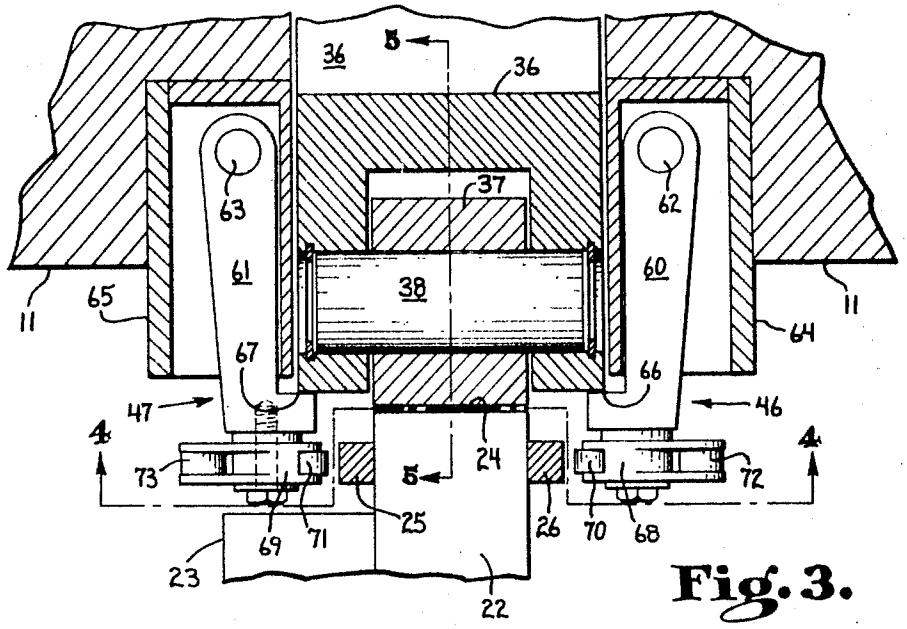

Fig. 3.

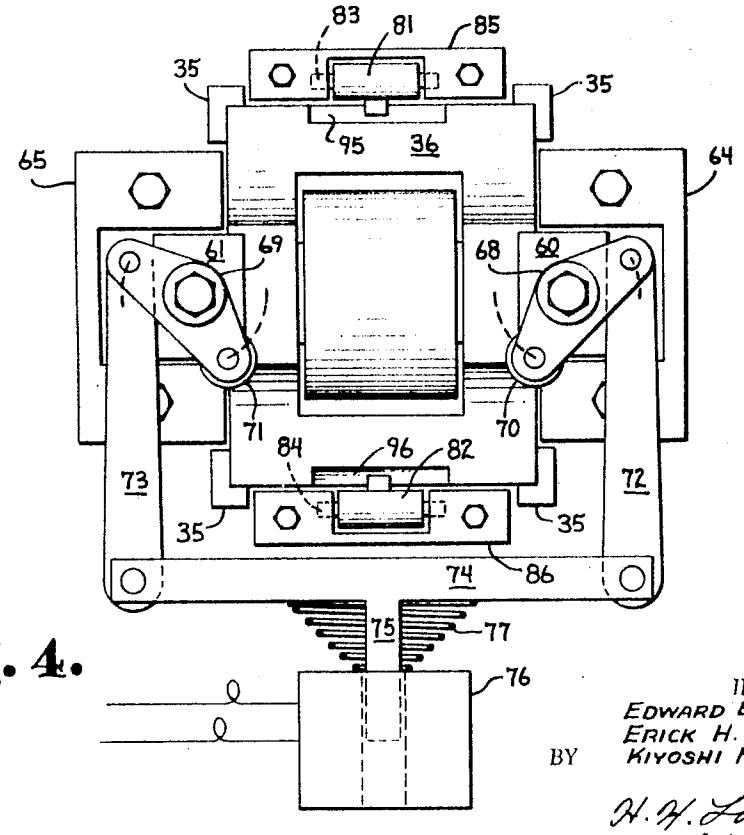

Fig. 4.

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CAM PLASTOMETER

Filed July 13, 1967 3 Sheets-Sheet 3

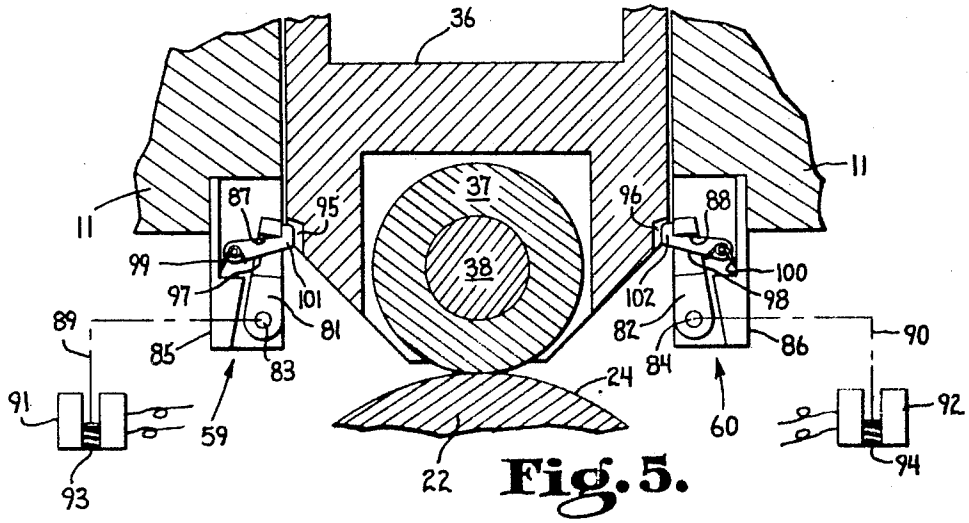

Fig. 5.

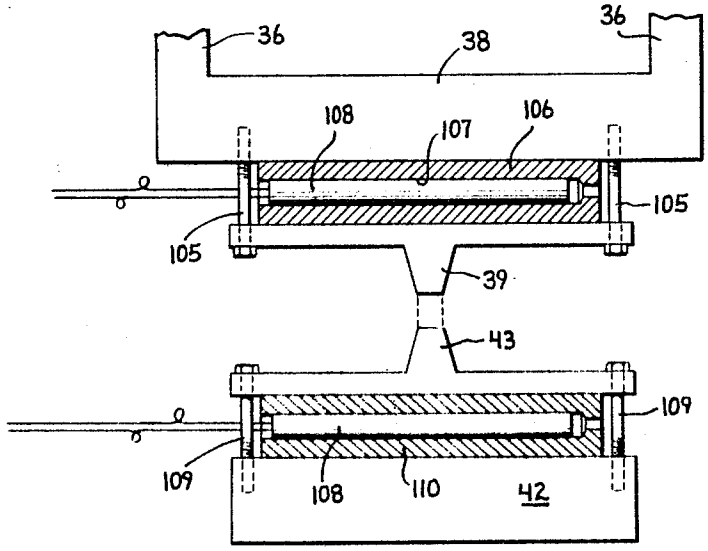

Fig. 6.

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3,457,779

CAM PLASTOMETER

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Int. Cl. G01n 3/10
U.S. Cl. 73—94 9 Claims

ABSTRACT OF THE DISCLOSURE

A machine for producing compression deformations of flat and cylindrical material specimens having a rotating cam to provide the deformation control of a press, the energy of the press being supplied by a power ram restrained by the rotating cam with latching means for holding the press out of operation of the cam and ram and to allow a single press or multiple presses to be effected at the speed of the cam under the speed stabilization of a flywheel.

BACKGROUND OF THE INVENTION

This invention relates to a material press or plastometer which is a machine or mechanism to produce plastic compressive deformations of materials. This basically simple task becomes complicated when high load requirements become coupled with high strain rates of predetermined and controlled nonconstant time/displacement characteristics.

Existing compressive loading units can be categorized into three basic groups as follows: (1) Slow operating constant deflection rate units that can be mechanically driven by conventional motors and reducers. The expenditure of energy being spread out over a long period of time keeps the power requirement in a reasonable range and can thus be supplied directly. (2) Impact hammers which are driven by gravity, mechanical springs, or pneumatic springs to supply deformation forces. However, the degree and rate of deformation is a random characteristic depending on hammer weight, impact velocity, specimen configuration, and the mechanical properties of the special material. (3) Controlled deformation of a compression specimen obtained by the action of a cam profile moving at a constant angular speed. In order to use this concept for test involving high strain rates, the required energy is obtained from high speed flywheels which also serve to minimize speed fluctuations. These units become very bulky requiring heavy transmissions, etc., when strain rate versatility is required.

SUMMARY OF THE INVENTION

The concept for a plastometer of this invention combines some of the advantages of some of the above discussed groups for obtaining compressive deformation at a controlled variable rate. A rotating cam is utilized to provide the deformation control, but it does not supply energy or power needed to deform the specimen. A power supplying ram is restrained by the cam so that the ram has a tendency to accelerate the cam during the compressive stroke. For this reason the speed controlling the enertia effect of a simplified flywheel system is used to control cam rotation velocity. The actual test deformation ram force is provided by a high pressure air piston with a short working stroke and a proportionally high ahead volume. By precharging this head volume to any desired gas or air pressure, a pneumatic spring is produced that is capable of exerting the required forces while its travel speed (including acceleration, etc.) is controlled by a cam follower incorporated in the piston rod extension.

By means of remotely controlled sears and latches, the piston is controlled to provide a single or multiple stroke operation. It is accordingly a general object of this invention to provide a plastometer having a pneumatically controlled compressive force controlled in speed of compression by a cam profile and with sears and latches arranged to permit single or multiple stroke operation.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other objects and the attendant advantages, features, and uses will become more apparent to those skilled in the art as a more detailed description proceeds when considered along with the accompanying drawings, in which:

FIGURE 1 is a side elevational view with parts broken away and parts shown in section to illustrate the device of this invention;

FIGURE 2 is an end elevational view with parts broken away and parts shown in section looking into the right hand end of FIGURE 1;

FIGURE 3 is a greatly enlarged sectional view of the sear means and related parts shown in FIGURE 1;

FIGURE 4 is a greatly enlarged bottom view of the sear means and related parts looking upwardly, as shown by the arrows of the sectional line 4—4 in FIGURE 3;

FIGURE 5 is an enlarged cross-sectional view of the latching means and related parts shown in FIGURE 1 on a sectional line 5—5 of FIGURE 3 looking in the direction of the arrows; and

FIGURE 6 is a partially elevational and partially sectional enlarged view of the compression and fixed jaws of the plastometer as shown in FIGURES 1 and 2.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring more particularly to FIGURES 1 and 2, the plastometer device is supported in a framework consisting of a base plate **10** supporting an upper mounting plate **11** by a plurality of posts or rods **12**. On the base plate **10** is mounted a motor power means such as an electric motor **13** coupled through a gear reduction means **14** to rotate a shaft **15** on which is fixed a pulley **16**. The pulley **16** has a belt **17** driven by the pulley **16** to drive a pulley **18** on a shaft **19** that is journaled in two bearing journals **20** and **21** supported on the underside of the mounting plate **11** by bolting, or other suitable means. The pulley **16** is of a larger size than the pulley **18** to produce an increase of speed of the shaft **19** over the shaft speed **15**. These pulleys are interchangeable to allow the reverse effect to be produced for precisely controlled low strain rates tests. The shaft **19** has a cam wheel **22** mounted thereon between the journals **20** and **21** and is supported in position on the shaft **19** by a mounting flange **23** which is bolted or otherwise suitably fastened to the cam wheel **22** so that cam wheel **22** may be replaced by other cam wheels having different cam surfaces **24**. Cam surface **24** consists of a short diameter surface **24'**, a long diameter surface **24''**, and controlled transitions between these surfaces. Cam wheel **22** also has cam blocks **25** and **26** mounted on the side periphery thereof in a position and for the purpose soon to be described. Shaft **19** also has a pulley **27** thereon with a belt, or preferably a plurality of V-belts, **28** surrounding the pulley **27** and a pulley **29** on a shaft **30** supported by a pair of journals **31** and **32** on top of the mounting plate **11** to drive a heavy flywheel **33**. The pulley **27** is much larger than the pulley **29** to provide an increase in speed of shaft **30** over the speed of shaft **19** to give flywheel **33** a high angular velocity. When the motor **13** is energized, pulley **16** driving through pulley **18** will rotate the shaft **19** with the cam wheel **22** thereon and at the same time produce a high rotative

speed of the heavy flywheel 33 to produce a substantially constant angular velocity of cam wheel 22.

Mounted on top of the mounting plate 11 is a housing or cage 35 of square or rectangular configuration exactly overlying a corresponding opening 34 in the mounting plate 11. Within this housing 35 is a cam follower support 36 on which is journaled a cam follower roller 37 by a bearing or journal pin 38. The cam follower support 36 is substantially hollow or U-shaped with a crosshead 38 near the upper end thereof on which is supported a compression jaw 39 fixed in a manner, as will be later more particularly described with reference to FIGURE 6. The cam follower support has circular openings or windows 40 through opposite walls in the area of the compression jaw 39 so that he compression jaw 39 may be viewed from the outside of the mechanism. Below the compression jaw 39 and crosshead 38 is a hollow portion 41 through which is supported a base plate 42 on which is mounted a fixed jaw 43. The base plate 42 is mounted on brackets fixed to the mounting plate 11 by bolting, or any other suitable manner, the bracket 44 also having a work table 45 mounted thereon which is in the same plane as the top of the fixed jaw 43 so that material to be pressed may be slid on the work table 45 to bring the material between the jaws 39 and 43 for the pressing operation. The cam follower support is normally held in a position in which the cam follower roller 37 just clears the cam wheel surface 24 by sear means 46 and 47, later to be described more fully in the detailed description of FIGURE 3.

Mounted on top of the cage or casing 35 is a fluid or pneumatic power cylinder 50 which may be mounted by flange means 57 with bolts or other suitable means for positioning the cylinder 50 directly over the cage or case 35. The pneumatic cylinder has a piston 52 reciprocably mounted therein with a power shaft 53 extending through an opening in the lower wall of the power cylinder 50 and journaled by a pin 54 to the upper end of the cam follower support 36. The power cylinder 50 is of substantially short stroke but of considerably large piston area to provide high energy compression in the manner of a pneumatic spring on the cam follower support 36. The piston chamber between the upper cylinder wall and the top of the piston 52 has a port 55 coupled through a fluid conduit, through a supply and exhaust valve 56, and a pressure regulator 57 to a fluid pressure source, such as air under pressure. The fluid pressure on the cylinder may be preset by pressure gage 58 and adjustment of the regulator 57, whenever the supply and exhaust valve 56 is rotated to admit air under pressure to the piston chamber, as shown in solid lines in the valve 56. Whenever it is desirable to relieve the pressure from above the piston 52, the supply and exhaust valve 56 may be rotated, as shown by the broken lines therein to connect the piston chamber with the exhaust port. When the sears 46 and 47 become operative to release the cam follower 36, 37, the cam follower will proceed through one cycle or one revolution of the cam wheel 22 and then be latched in its uppermost position by latch means 59 and 60, shown in FIGURE 2, the construction and operation of which will be more fully described in connection with FIGURE 5. When material is to be placed between the jaws 39 and 43, this material is laid on table 45 with the portion to be pressed between the jaws 39 and 43 and the air pressure regulated by the regulator 57 and supplied to the piston chamber above piston 52 through the supply valve 56. The piston is then held as a pneumatic spring by the sear means 46 and 47 on the cam follower 36, 37 until the sear means are released to permit the cam follower roller 37 to ride directly on the cam wheel 22 surface 24' and control the downward stroke of the compression jaw 39 on the work piece in accordance with the pressure exerted by the piston 52. As the cam follower 36, 37 follows the cam surface 24' in the downward stroke, the latch means 59 and 60 will be released such that when

the cam follower roller 36 returns to the high portion of the cam surface 24'', the latch means 59 and 60 will catch the cam follower support and hold it against further cam follower travel, as will later become clear in the description of the FIGURES 3, 4, and 5. As may be seen in the description of FIGURES 1 and 2, the cam follower 36, 37 is released to follow the cam surface 24 and as the follower roller 37 proceeds towards a shorter diameter of the cam wheel 22 it will tend to accelerate the rotation of the cam wheel 22, but this tendency to accelerate is opposed by the action of the heavy flywheel 33 thereby keeping the cam wheel 22 at a substantially constant angular velocity.

Referring more particularly to FIGURES 3 and 4 there is shown a greatly enlarged view of the sear means 46 and 47 of FIGURE 1. The sear means consists of a pair of lever arms 60 and 61 pivoted at their upper ends by journals 62 and 63 in block members 64 and 65 mounted by cap screws or other suitable means to the lower side of mounting plate 11. Each lever 60 and 61 has a shoulder portion 66 and 67 which underlies the lower ends of the cam follower support 36. On the lower end of each lever 60 and 61 is mounted a rocker arm 68 and 69, respectively, as by stud bolt journals or any other suitable means. In a slotted opening on the inner end of each rocker arm is mounted a cam follower roller 70 on the rocker arm 68 and a similar roller 71 on the rocker arm 69. On the outer end of each rocker arm 68 and 69 is a connecting link 72 and 73, respectively, the lower end of each of which is coupled by a cross bar 74 having an armature 75 affixed thereto which is operative in an electromagnet device 76. The cross bar 74 is biased away from the electromagnet by a spring 77 to hold the rocker arms 68 and 69 in a position shown by the broken line arcs to hold the cam follower rollers 70 and 71 out of engagement with the cam blocks 25 and 26, as shown in FIGURES 1 and 3. Whenever the electromagnet 76 is energized, the cross bar 74 is pulled downwardly pulling the links 72 and 73 along to rotate the rocker arm 68 clockwise and the rocker arm 69 counterclockwise closing the gap between the cam follower rollers 70 and 71 to bring them in a position to ride up the cams 26 and 25, respectively. When cam rollers 70 and 71 ride up cam blocks 26 and 25, respectively, the lever arms 60 and 61 will be rotated outwardly to disengage the sear portions 66 and 67 from under the cam follower support 36 allowing the cam follower roller 37 to engage the cam wheel surface 24. As may be seen in FIGURE 2, this operation of releasing the sears from the cam follower support 36 is at a point on the cam wheel cylindrical surface 24 just preceding its reduction in diameter portion 24' so that there will be no hammer effect between the cam follower and cam wheel surface since the cam follower is retained by the sears at a very close tolerance such as .005 of an inch above the cam surface at its cylindrical diameter. Energization of the electromagnet 76 will cause release of the sear means 46 and 47 but more than one cycle of compression on the work piece by the compression jaw 39 may be obtained by continuing the energization of the electromagnet 76, as will later be described.

Referring more particularly to FIGURES 4 and 5, the latch means 59 and 60 is comprised of heavy lever means 81 and 82, journaled by pins 83 and 84 on their lower ends in brackets 85 and 86 supported by cap screws or other means to the underside of the mounting plate 11. The upper end of each lever arm 81 and 82 has a shoulder portion 87 and 88, respectively. The pins 83 and 84 have mechanical means thereon, as shown by broken lines 89 and 90, between the armature of electromagnets 91 and 92 biased by springs 93 and 94 to rotate the lever arms 81 and 82 into the path of the cam follower support 36. The cam follower support has notches 95 and 96 milled into the bottom of the cam follower support 36, as shown, to effect this latching means. The

latch 81 is retained out of latching position by a dog 97 and the latch 82 is retained out of latching position by the dog 98, these dogs being biased in a latching position by springs 99 and 100, respectively. Each dog has a projecting portion 101 and 102 in the path of the cam follower support 36 such that whenever the sear means 46 and 47 release the cam follower 36, 37 to follow the cam surface 24 the projections 101 and 102 of the dogs 97 and 98 are rotated downwardly against the springs 99 and 100, respectively, to release the latches 81 and 82 to ride against the outer surface of the cam follower support 36 by the bias of springs 93 and 94, respectively. When the diameter of the cam wheel 22 increases to its highest point 24", latch 81 will fall under the notch 95 and latch 82 will fall under the notch 96 to hold the cam follower support 36 in its upper position. The long diameter portion 24" of cam surface 24 is shown exaggerated in FIGURE 2 but may be in the order of .010 longer than the normal cylindrical surface. While the electromagnets 91 and 92 are shown separately for convenience herein, a single electromagnet may be used by the couplings 89 and 90 connecting both pins 83 and 84 to the single electromagnet. The above described cam follower 36, 37, when released by the sear means 46, 47, will go through one cycle or one revolution around the cam surface 24 of cam wheel 22 and then be latched out of further operation. When latch means 59, 60 are holding the cam follower in its uppermost position, the sear means 46, 47 can engage and hold cam follower 36, 37. The latches may be reset by energization of electromagnets 91 and 92 to rotate the latch lever 81 counterclockwise and the latch lever 82 clockwise until the dogs 97 and 98 again latch these levers out of the path of the cam follower support 36.

Referring more particularly to FIGURE 6, the crosshead portion 38 in the cam follower support 36 supports the compression jaw 39 in any suitable manner, herein shown to be stud bolts 105. Between the web portion 38 and the compression jaw 39 may be placed a block 106 with a plurality of parallel cylindrical openings 107 into which may be placed electrical heating elements 108. Heating elements 108 may be energized to cause the compression jaw 39 to be heated to a desirable temperature. In like manner the fixed jaw 43 may be supported on its support 42 by cap screws 109, or any other suitable means, as desired. In like manner a block 110, having a plurality of parallel cylindrical openings similar to or the same as the block 106, has heating elements 108 for the purpose of heating the fixed jaw 43. Heating of these jaws may be desirable where thermoplastic material is to be compressed between the jaws 39 and 43.

OPERATION

While the operation of the press may be obvious from the above detailed description of the several figures, let it be assumed by reference to FIGURES 1 and 2 that motor 13 is energized to bring the cam wheel 22 up to a constant speed which is maintained stable by the heavy flywheel 33. Supply and exhaust valve 56 is placed to pressurize the piston chamber above piston 52 at a pressure set by regulator 57 for the particular material to be compressed by the jaws 39 and 43. When a piece of the material to be pressed is laid on work table 45 and between the jaws 39 and 43, the electromagnet 76, as shown in FIGURE 4, may be energized to swing the rocker arms 68 and 69 into position shown by the broken line arcs to cause the cam blocks 25 and 26 to remove the sears 66 and 67 from under the cam follower support 36 releasing the cam follower to allow roller 36 to engage cam wheel surface 24 as cam wheel 22 rotates in the direction of the arrow shown in FIGURE 2. The power cylinder 52 will force the compression jaw 39 downwardly as rapidly as the cam surface 24' will permit cam follower wheel 37 to follow until complete compression is exerted on the work piece. The greatest pressure will be exerted on the work piece when the cam follower wheel 37 is at the shortest diameter of the cam surface 24' and thereafter the cam follower will be forced upwardly until it reaches the greatest diameter of cam surface 24". In the downward travel of the cam follower support 36 the dogs 97 and 98 are forced out of holding position for the latches 81 and 82 so that when the high diameter cam surface 24" is reached the cam follower 36, 37 is returned to its high position at which time latches 81 and 82 fall into the notches 95 and 96 to retain the cam follower in its upper position. If electromagnet 76 is held energized and electromagnets 91 and 92 are energized in quick succession the sear means 46, 47 will be held in position to have the cam follower roller 70 and 71 to engage the cam blocks 25 and 26 repeating the release of the cam follower support 36 for rapid repeated compressions by the jaws 39 and 43. If electromagnet 76 is momentarily energized or held energized the cam follower 36, 37 will travel through just one cycle and be locked up by the latch means. Accordingly, the operator can control the cam plastometer to make a single stroke compression as he feeds the material under the jaws 39 and 43 or he can operate the device to produce repeated compressions on the same portion of the work piece or as the work piece is fed through the jaws 39 and 43. By this means overloading of the machine is prevented when pressing unknown materials where resulting loads may exceed the load capabilities designed into the machine. If the specimens reaction to loading exceeds the force supplied by the air cylinder ram, the ram will stall out and thus lift the cam follower 36, 37 from the cam surface 24' which normally controls the deformation profile and thus avoid overload damage.

While many modifications and changes may be made in the constructional details and features of this invention in carrying out the spirit of this invention, it is to be understood that we desire to be limited in the scope of our invention only by the limits of the appended claims.

We claim:

1. A cam plastometer comprising:
   - a journaled cam wheel driven in angular rotation by motive means;
   - a flywheel coupled to said journaled cam wheel and driven thereby to stabilize the angular rotation of said cam wheel;
   - a cam follower engagable with said cam wheel, said cam follower having an extension supporting a compression jaw oriented to advance in compressive force toward said cam wheel;
   - a power cylinder coupled to said extension to power said cam follower toward said cam wheel;
   - a fixed jaw under said compression jaw to be engaged by said compression jaw when said cam follower is powered by said cylinder toward said cam wheel;
   - sear means engagable with said cam follower to hold said cam follower from following said cam wheel, said sear means having a remotely controlled actuator to actuate said sear means to be released by said cam wheel to allow said cam follower to follow said cam wheel; and
   - latch means engagable with said cam follower to hold same free of said cam wheel, said latch means having dogs biased to hold said latch means out of engagement with said cam follower, said dogs having a portion in the path of said cam follower to release said dogs from holding said latch means out of engagement of said cam follower whereby said cam follower will be enabled to follow said cam wheel through one cycle of rotation before being latched by said latch means.

2. A cam plastometer as set forth in claim 1 wherein: said flywheel is coupled to said journaled cam wheel by pulleys and belts, said pulleys being associated

in size to cause said flywheel to rotate a higher angular velocity than said cam wheel.

3. A cam plastometer as set forth in claim 2 wherein: said cam follower constitutes a roller element in a follower support with said roller element engagable with said cam wheel, and said cam wheel has a cam surface that is circular over a portion thereof and a portion of gradual reduction in diameter to a low diameter point.

4. A cam plastometer as set forth in claim 3 wherein: said power cylinder is a fluid cylinder with means to regulate the fluid pressure and thereby control the exerted power of said fluid cylinder.

5. A cam plastometer as set forth in claim 4 wherein: said compression and fixed jaws each have heating elements embedded thereunder whereby the jaws may be heated to a predetermined temperature.

6. A cam plastometer as set forth in claim 5 wherein: said sear means are a pair of pivotal levers, each having a shoulder portion adaptable to underlie said cam follower support opposite the pivot thereof, each lever having a rocker arm centrally pivoted normal to the pivot of said pivotal levers and having a cam follower portion in the path of the peripheral sides of said cam wheel, the peripheral sides of said cam wheel each having a cam surface thereon, said rocker arms being mechanically coupled to be rocked to place each cam follower portion in the path and out of the path of said cam surfaces whereby rotation of said rocker arms for engagement of said cam follower portion with said cam surfaces on said cam wheel releases said shoulders underlying said cam follower support to allow said cam follower to follow said cam wheel.

7. A cam plastometer as set forth in claim 6 wherein: said latch means includes a pair of lever arms diametrically opposed about said cam follower with the pivot of each on the lower end and the upper end engagable with the bottom edge of said cam follower support, each lever having a dog spring biased to hold each lever out of the path of said cam follower support and having a portion on said dog engageable by the cam follower support in its downward travel to release said levers to latch and hold said cam follower support when said cam wheel returns said cam follower to its uppermost position of travel whereby said cam followers, upon being released by said sear means, will follow the surface of said cam wheel pushing said dogs to release said latch means levers to ride against said cam follower support until said cam wheel surface forces said cam follower to its uppermost position at which time said latch means levers engage said bottom edge of said cam follower support restraining it from downward movement.

8. A cam plastometer as set forth in claim 7 wherein: said sear means and said latch means are actuated by electromagnetic means.

9. A cam plastometer as set forth in claim 8 wherein: said cam follower portion on said rocker arms are rollers.

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