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COLD-HEADING

MACHINES, METHODS AND TOOLS USED FOR THE COLD-HEADING OF SCREWS, RIVETS AND SIMILAR MACHINE PARTS

BY CHESTER L. LUCAS

MACHINERY'S REFERENCE BOOK NO. 119
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NUMBER 119

COLD-HEADING

By CHESTER L. LUCAS

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CHAPTER I

PRINCIPLES OF COLD-HEADING

The operation of forming the heads of rivets, wood screw blanks, machine screw blanks, and similar products, by upsetting the ends of the wire lengths while cold, is known as cold-heading. The machines to which the wire is fed from a coil, and in which it is cut off and headed, are known as cold-headers. It is the purpose of this treatise to describe briefly the operation of various types of heading machines, to enumerate some of the limitations and possibilities of the different cold-heading machines and to give a general idea of the way in which the tools are planned and made for this class of machinery. No attempt will be made to cover the heading of hot stock such as is followed in making hot-formed bolts, as this type of machinery comes under the head of forging machinery, and is separately described in MACHINERY's Reference Books No. 113, "Bolt, Nut and Rivet Forging," and No. 114, "Machine Forging."

Principles of Cold-heading

If we should cut off a piece of ⅜-inch diameter copper wire about 1 inch long, stand it on end on a hardened steel block, as shown at *A*, in Fig. 2, and strike it squarely on top with a heavy hammer, we would upset the piece as a result of the blow, causing it to bulge considerably at the center, the amount depending upon the force of the blow, leaving it with an appearance as indicated at *B*, Fig. 2. Continuing our experiments, if we take another ⅜-inch piece of copper wire, 1 inch long, as before, and drop it into a ⅜-inch hole in a hardened steel block, allowing a section ½ inch long to extend above the surface of the block, as at *C*, Fig. 3, and strike the end of this piece a square blow with the same hammer, the piece will assume about the appearance indicated at *D*, in Fig. 3. The projecting section will be bulged as before, but the part of the blank remaining within the block must necessarily retain its original shape, as it is confined in all directions. Continuing our experiments still further, if we take a new blank of the same dimensions and insert it in the same block as before, but in place of the flat ended hammer we use one with a cup-shaped depression turned in its face, as shown at *E*, Fig. 4, and strike the blank a hard blow squarely upon the projecting end, the end of the wire will necessarily take on the appearance indicated at *F*, Fig. 4. The blank *must* assume this shape because the part under the head is confined within the lower block and the head section is guided in its bulging by the cup-shaped depression in the hammer with which the blow is struck.

These three simple experiments outline the principles involved in cold-heading. In all cold-heading operat confined at

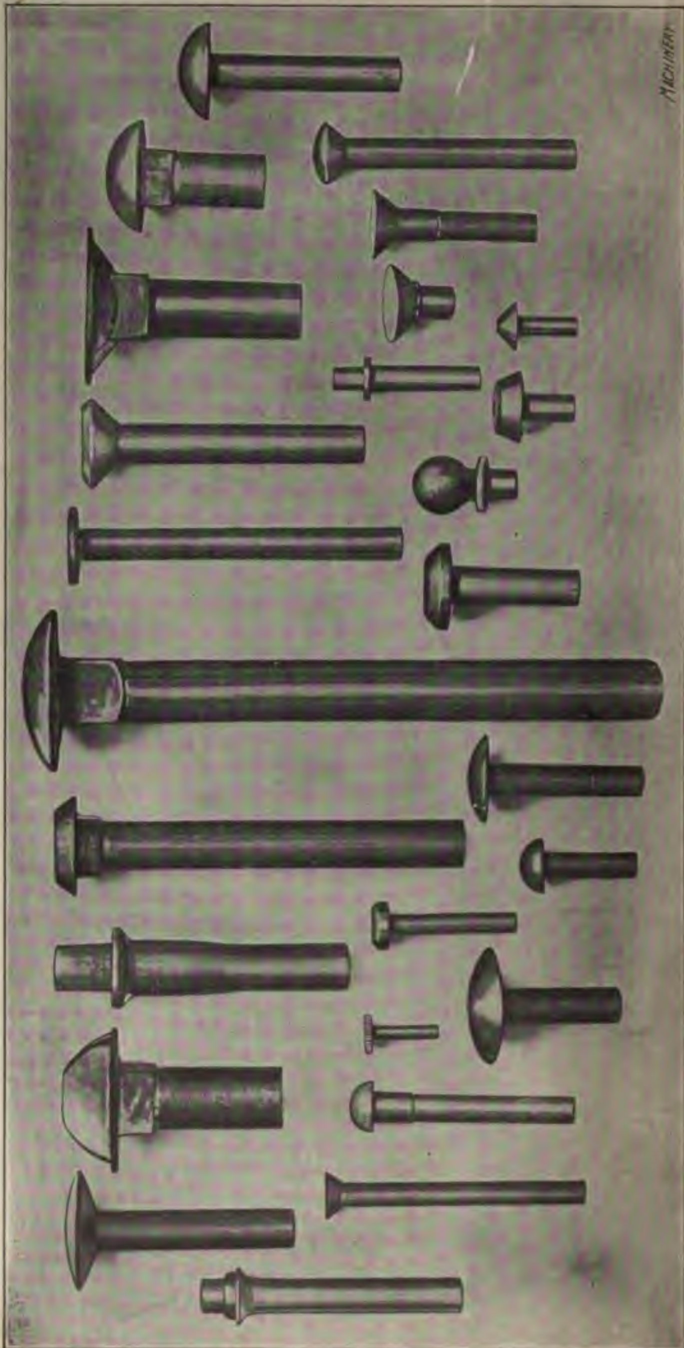
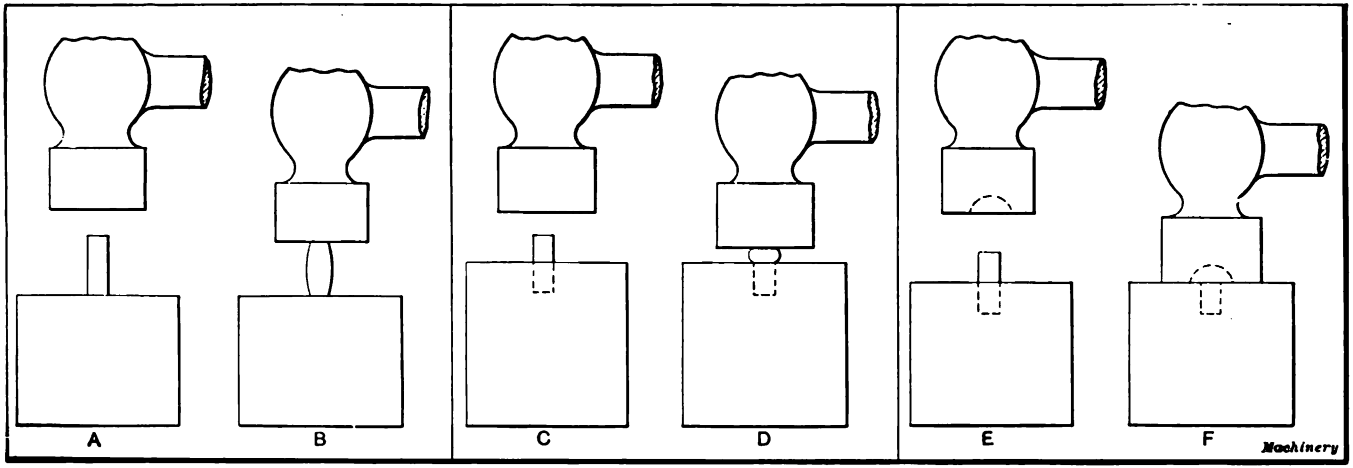


Fig. 1. Miscellaneous Samples of Cold-heading made on E. J. Manville Machines



Figs. 2, 3 and 4. Illustration of Principles of Cold-heading

bottom and sides, leaving the metal which is to com- the head projecting, so that it may be upset and d by the punch of the heading machine. In cold- g, the fundamental point to be remembered is that, ressure, the wire stock will always flow in the direc- the least resistance.

Early History of Cold-heading Machinery

use of hand-formed rivets dates back to the ancient ians, but this article must be confined to the machines and tools used for automatically producing rivets and screw blanks. The first instance we find of cold-heading by machinery was in England, about 1760, when two brothers, John and William Wyatt, designed and built a machine for heading wood screw blanks. In America, there is no doubt that Josiah Gilbert Pierson's cold-header, patented March 23, 1794, was the first machine of its kind, although the patents were destroyed when the patent office was burned early in the last century. Pierson's factory was first on the site of the present New York Produce Exchange, but later he moved to Ramapo, N. Y. His heading machine was a massive affair, with a heavy framework anchored to the floor. A large flywheel was provided, and the machine was operated on the now familiar toggle principle. In 1838, the Eagle Screw Co., of Providence, R. I., was started by William G. Angell, and its earliest machine was what is known today as the old Eagle header. At the factory of the American Screw Co., Providence, R. I., this type of machine is used today on certain classes of work. Mr. Benjamin Thurston, superintendent of the American Screw Co., states that in the early days of cold-heading each machine was mounted upon the ends of long posts which ran through the floor down to a solid ground foundation.

An Old Type of Header

In Fig. 5 is shown one of the earliest cold-heading machines now in existence, and while it has long ago out-lived its usefulness, it is inter-

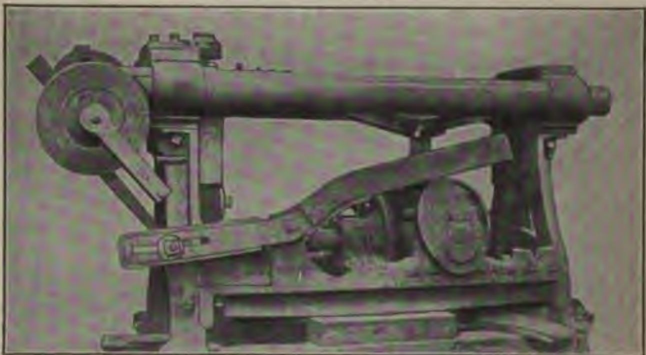


Fig. 5. An Old Type of Header

esting to compare it with modern heading machines. This machine was designed by W. E. Ward and built by Russell, Burdsall & Ward, of Port Chester, N. Y., at some time prior to 1856. The line engraving Fig. 6 gives an idea of the general principles upon which this machine operated, from which it will be seen that the operation of the punch was effected by means of toggle mechanism actuated by a cam on the lower shaft of the machine. The vertical cross-section through the dies is indicated at the left. As the machine was of the open-die type, the lower die was actuated by another cam. Two extremely heavy rods extended the length of the sides, as shown in the engraving, Fig. 5, and in section in the illustration, Fig. 6. These served to tie the machine together, enabling it to better withstand the heading operation. The output of this machine, which was used for making stove bolts ¼ to ⅜ inch in size, was about 30,000 headed pieces per day of eleven hours.

Operating Principle of Modern Heading Machines

Practically all modern heading machines operate upon the same *general principle*, although there are many modifications and features which each maker considers best. By referring to Fig. 7, which shows the plan view of a modern single-blow solid-die heading machine, it will be seen that there is a heavy framework *A*, at one end of which is located the driving shaft *B*, rotated by a driving wheel at the right-hand side; at the other end is located the die-block *C*. Between the sides of the heavy framework is a movable ram *D* which serves to actuate the heading punch *E*. The wire, which is indicated at *F*, enters the machine through feed rolls *G* and thence through the framework of the machine, passing through the cut-off quill *H*. At the left-hand side of the machine is supported the bracket *I*, in which slide *J* may be reciprocated by means of a crank motion from the main driving shaft. Slide *J* contains a cam groove in which roll *K* is fitted, and as roll *K* is mounted upon the cross-slide *L*, it will be seen that a lateral motion is thus imparted to the cut-off knife *M*, located on the

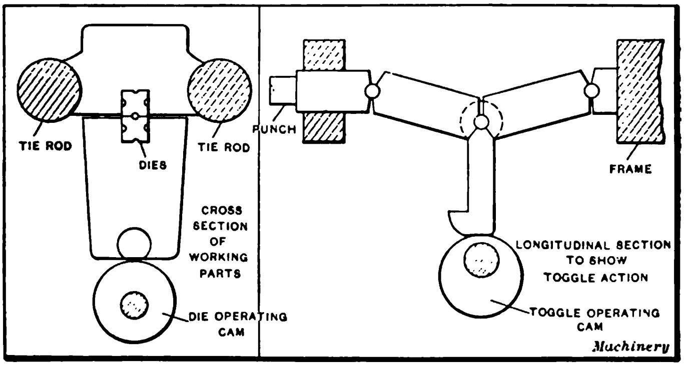


Fig. 6. Diagram illustrating Operation of Header shown in Fig. 5

end of cutter bar. The ratchet feed advances the wire through the cut-off quill to the feed stop, not shown, after which cut-off knife *M* is advanced in the manner just described, severing the wire, but retaining it on the cut-off blade by means of a spring finger. The advance of the cut-off knife and wire is continued until it reaches a position directly in front of the opening in die *N*. At this position it is held stationary long enough for punch *E* to begin to push it into the die, at which time the cut-off knife retreats and allows the punch *E* to continue its work by pushing the blank to the bottom of the die cavity, afterward upsetting the projecting part of the wire to form the head. The wire blank *F*, when pushed into the die, is prevented from passing too far by a backing pin *O*. After the piece has been headed, the backing pin is advanced by ejecting mechanism operated by lever *P*, which receives its motion from a crank on the right side of the machine connected to the main driving shaft. This, briefly stated, is the general principle upon which all modern heading machines of the single-blow solid-die type operate.

There are two distinct principles employed for recipro
movable ram of a cold-header. These are the crank or

ɡle principle. In the machine just described and illustrated in Fi; notion is transmitted to the ram by means of an eccentric upon tl

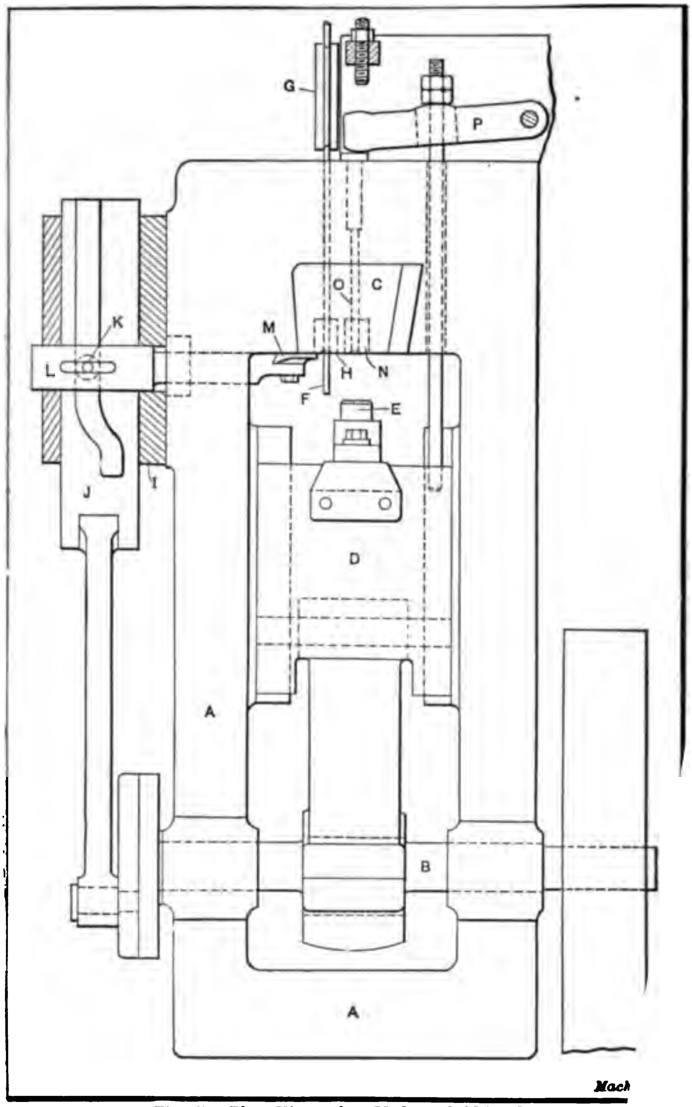


Fig. 7. Plan View of a Modern Cold-header

driving shaft, the eccentric, of course, being a modificati crank principle. By referring to the diagram Fig. 8, it w that in the crank-operated header the length of the strol to the diameter of the crankpin circle, and that one strok plished in each revolution of the driving shaft from which the crank is operated.

The crank principle is employed on most single-stroke machines and by one manufacturer for double-stroke machines as well. On double-stroke cold-headers of the crank-operated type, it will be seen that the crankshaft must make two revolutions to secure the two strokes, and

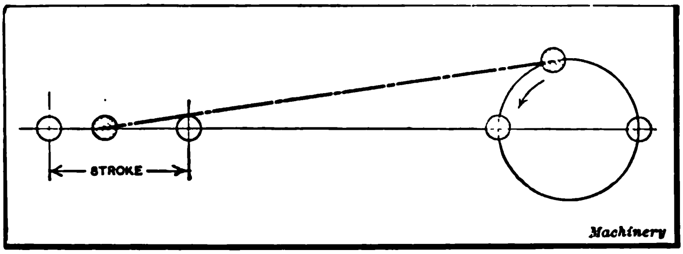


Fig. 8. Diagram to illustrate Operation of Crank Headers

these two strokes will be of equal length. The blow secured by the crank-operated header is of a quick punching character rather than a gradual squeezing operation, and exponents of crank-operated headers consider this feature to be of great importance.

Toggle-operated Headers

The other principle upon which cold-headers operate is the toggle principle, of which there are several variations. The common type of

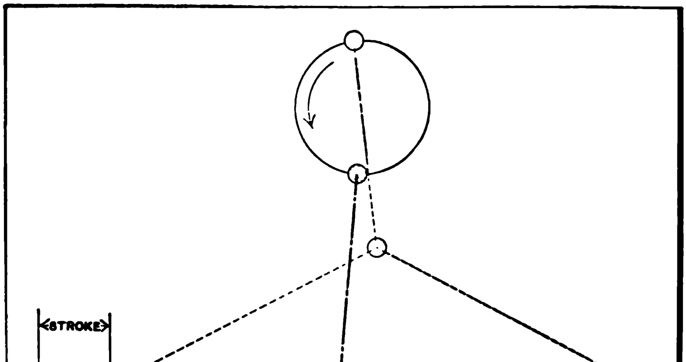


Fig. 9. Diagram to illustrate Operation of Toggle Headers of Two-cycle Type

toggle action is that shown in Fig. 9, in which the toggle is straightened by a crank-actuated link, which brings the arms of the toggle to a straight line once during each revolution of the crankshaft. This, of course, gives one stroke of the ram to [illegible] e crank-shaft, but the blow obtained is of a gr[illegible] especi-ally at the ends of the stroke whe[illegible] is being done. This type of toggle mechanism is known as the two-cycle type, two revolutions of the crankshaft being necessary to complete a "two-blow" rivet. Another type of toggle operating mechanism which is extensively used on the double-stroke machines is illustrated in Fig. 10, from which it will be seen that two blows are struck at each revolution of the crankshaft which operates the arms of the toggle. As this type of machine makes a two-blow rivet in one revolution, it is termed a "one-cycle" machine. The chief difference between the two-cycle type of toggle action and the one-cycle type lies in the fact that in the two-cycle mechanism the toggle is straightened when

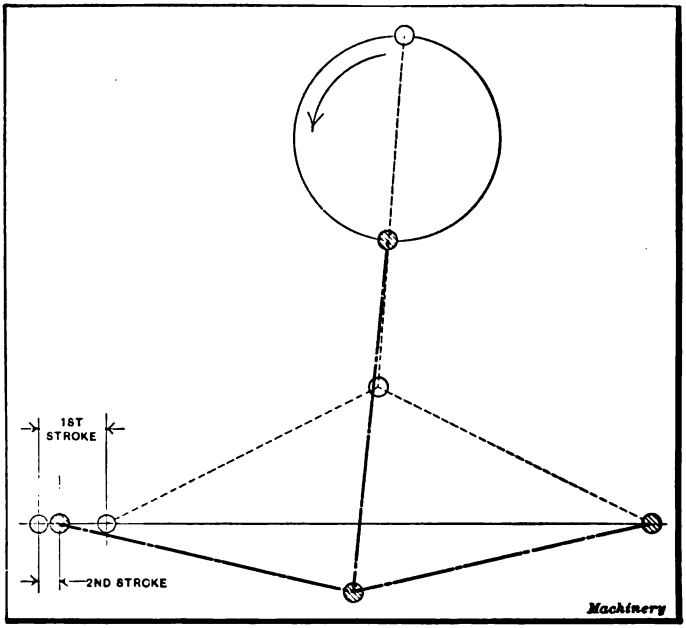


Fig. 10. Diagram to illustrate Operation of Toggle Headers of One-cycle Type

the extreme of the crank motion is reached, but in the one-cycle mechanism it is straightened midway of the extreme distance of the crank, so that in the latter machine two blows are secured during one revolution of the crankshaft. The two strokes may be of equal length; the first stroke may be the longer, or *vice versa*, by varying the distance between the crankshaft and the line of the straightened toggle. In Fig. 10, the first blow is the long blow as the toggle is pushed down to the straightening point. As the toggle is drawn further above the straightening line than it was below, the second blow will be the short one, as indicated.

Double-stroke Cold-headers

In describing the header illustrated in Fig. 7, it was stated that this was a single-stroke machine as contrasted with a machine for striking two blows on each piece. A great many jobs of heading, however, cannot be adequately handled on a single-stroke machine, as there is too much metal to be upset in the head. When the amount of metal to be put into the head exceeds two and one half diameters of the wire in length, it is necessary to employ a double-stroke machine. The double-stroke machine operates in practically the same way as that shown in Fig. 7, except that it strikes two blows in rapid succession upon the wire blank before it is ejected. The preliminary blow is known as the coning blow; in this the wire is partly upset and prepared for the second blow which finishes the head. The two punches are "slidably" held on the ram, and the mechanism for changing the positions of the dies for the two blows is called the rise-and-fall motion. While there are several different means of securing this motion,

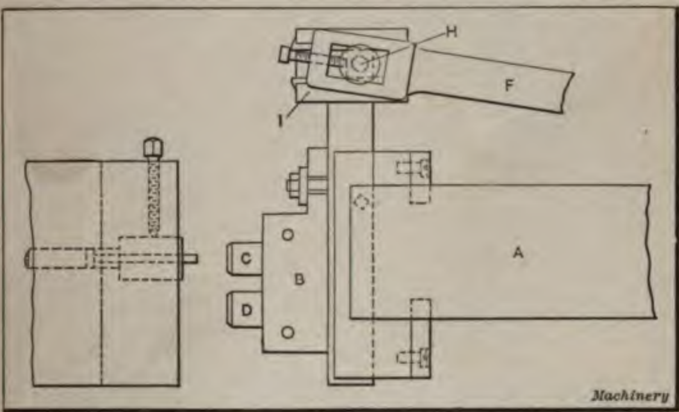


Fig. 11. Mechanism for operating Ingraham Rise-and-fall Motion

the Ingraham rise-and-fall motion used on Blake & Johnson cold-headers is typical. By referring to the line illustration Fig. 11, which shows a side elevation of the principal parts, in connection with the halftone illustrations Figs. 12 and 13, the operation of this device can be readily followed. Upon the end of ram *A*, the die-holding slide *B* is secured. This slide is free to move vertically so that upper punch *C* or lower punch *D* may be operated in alignment with the stationary die. In Figs. 12 and 13, these dies are not shown. Pivoted upon bracket *E*, which is bolted to the left side of the frame, as shown in Figs. 12 and 13, is the lever *F* which controls the rise-and-fall movement of the punch slide. This lever is actuated by a cam upon the driving shaft of the machine, as indicated at *G*, Figs. 12 and 13. At the opposite end of lever *F*, a bearing pin *H* is adjustably mounted, being free to slide in the ways provided in section *I* of the punch-holding slide. Thus by having cam *G* of the proper shape, the rise and fall of punch-holding slide *B* may be so timed that at the time of the position of the first blow, punch *C* will be in line with the die, and at the time of the position of the second blow, punch *D* will be in line with the

It is obvious that on double-stroke machines, the wire feeding, -off and ejecting mechanism must be geared to agree with every ond stroke of the ram.

Triple-stroke Headers and Reheaders

In addition to single- and double-stroke machines, triple-stroke eaders are sometimes used where the amount of metal to be dis-

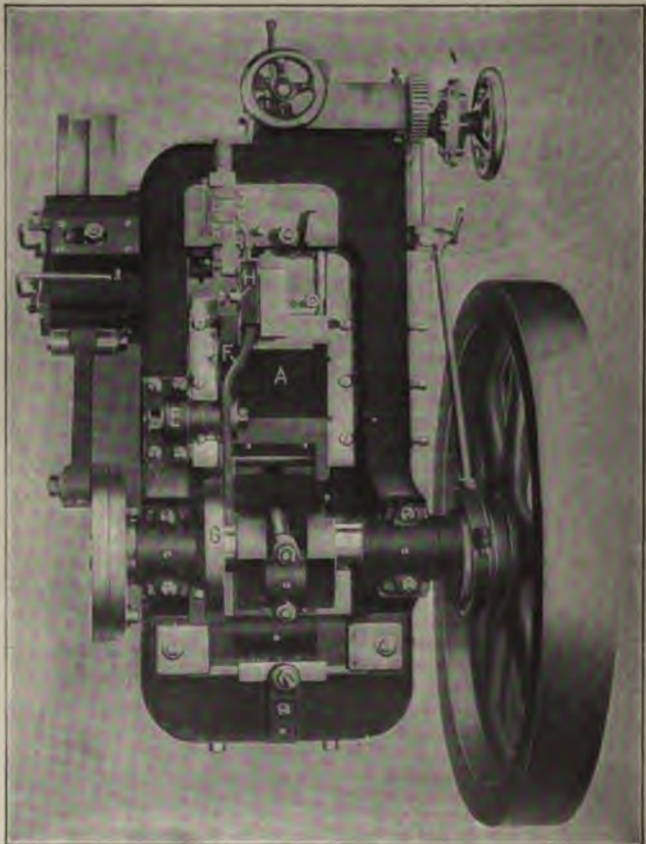


Fig. 12. Plan View of Blake & Johnson Double-stroke Solid-die Header

placed is more than can be effected with two blows. Triple-stroke headers are similar in action to other headers, except that three blows are struck. Two blows, however, will usually upset the metal of most heads to a point of crystallization so that except in special instances the use of a third blow would be of no advantage, because the blanks would require annealing before a third blow could be struck. Many heading jobs require two distinct operations to perform the work, usually on account of the shape of the pieces. For this purpose the work is carried as far as possible with an ordinary single or double-stroke header, after which the pieces are annealed and completed in a reheader. By means of an automatic hopper feed, the partly formed pieces are placed in the heading dies and the subsequent operations performed. Reheaders are made with strike one, two or three blows.

Open-die Machines

Thus far we have only described single- and double-stroke machines of the solid-die type, but for handling work in which the length of

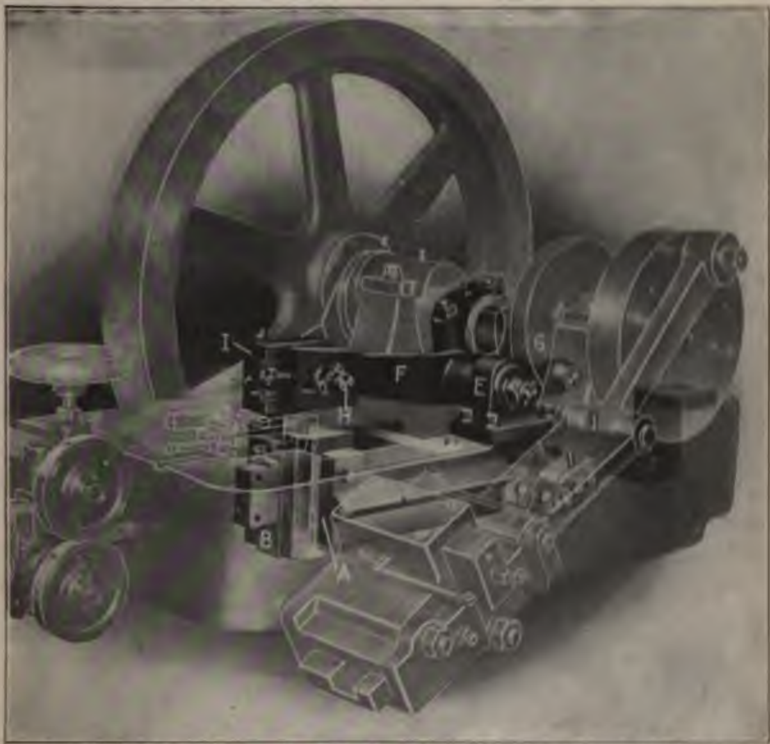


Fig. 13. Phantom View to illustrate Operation of Ingraham Rise-and-fall Motion

the pieces under the head exceeds nine or ten diameters of the wire, it is necessary to employ dies which open longitudinally to make ejection of the work possible. The heading operation upsets the metal of the blank for its entire length in addition to the upsetting of the head, so that the metal of the shank is squeezed out against the sides of the die. In the case of a solid die this upsetting of the metal in the shank makes the resistance to ejection too great, especially when the work has a very long shank.

Cold-headers employing open dies require die-operating mechanisms of an entirely different character from that which is used in solid-die machines. By referring to Figs. 14 and 15, the operation of the dies of a machine of this type may be followed. Referring to Fig. 14, the framework of the header is shown at *A*, the ram at *B*, and the

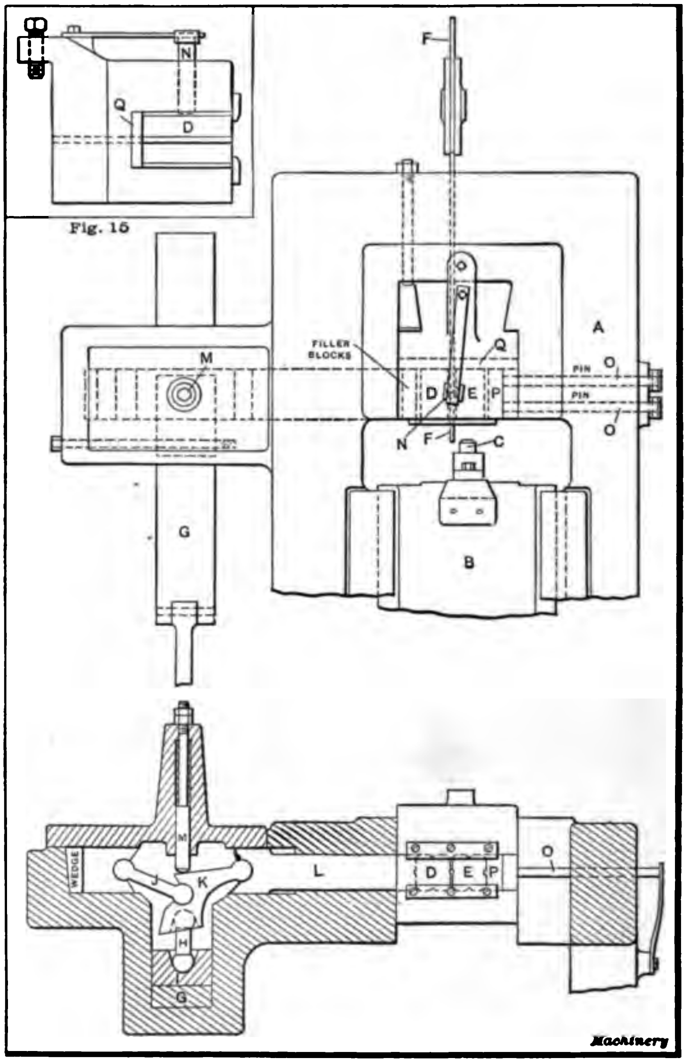


Fig. 14. Construction of Die-operating Mechanism for Open-die Headers. Fig. 15. Side Elevation of Dies and Spring Pin

punch at *C*. The two halves which constitute the dies are shown at *D* and *E*. The wire, which is indicated at *F*, runs through straightening rolls of the usual type through the framework of the machine as well as the die-holding block, and thence through the dies themselves. In feeding, the wire is run out against a stop, not shown, and is cut off by the movement of the two halves of the die in unison toward the right, which also brings the wire blank over into line with the heading punch C. Different makers of cold-headers use different methods for moving the die-blocks, and one of these constructions is here illustrated. The action of this mechanism is best shown by the sectional view in Fig. 14. A flat cam G is reciprocated by a crank connection to the driving shaft of the machine. When this flat cam is pushed in, it raises the toggle of which arms *H* and *I* are members. This action tends to straighten another toggle composed of arms *J* and *K*, and in straightening the latter toggle, slide *L* is made to push die-halves *D* and *E* laterally, thus severing the wire and moving it into the heading position. A spring pin *M* assists in returning the toggle mechanism for another operation. By referring to the sectional illustration, it will be seen that the corners of the two halves of the die are chamfered. A wedge pin *N*, more clearly shown in the smaller illustration, Fig. 15, fits into this chamfered opening at the parting line, and by means of a flat spring which presses downward upon the wedge pin, it tends to force the dies apart whenever lateral pressure is removed. This, of course, facilitates the ejection of the headed piece, which takes place when the new length of wire comes forward. Similarly, two spring pins *O* are provided which press against a filler block *P* on the opposite side from the die-operating plunger *L*. These serve to return the dies to the cut-off position after the piece has been headed.

In the heading position the rear end of the wire blank is backed up by backing plate *Q*, which is of hardened steel, so that the rivet or screw blank is effectively contained while being headed. From this construction it will be seen that the length of the dies must be the exact length of a headed rivet or screw blank measured under the head.

CHAPTER II

COLD-HEADING MACHINES AND OPERATIONS

In the preceding chapter the principles of cold-heading, together with its early history and a general outline of the machines employed, were given. In this chapter a brief description of representative machines of each of the principal types of cold-headers will be given, with statements of the possibilities and limitations of the work which may be done on each of these classes of machines. From the preceding pages it will be gathered that all cold-headers, whether of the crank- or toggle-operated types may be divided into single- and double-stroke machines on the one hand, and into solid- and open-die machines on the other hand. When we consider that single-stroke machines may be of solid- or open-die types, and double-stroke machines of solid- or open-die types either crank- or toggle-operated, and that the toggle-operated machines may be either one- or two-cycle type, it will be seen that to describe each of the combinations that are found in cold-heading machinery would be an endless task. In addition to the above-mentioned class of heading machinery, there are reheaders of single-, double- and triple-strokes; and in the special industries like that of tack- and nail-making the machines are still more special, but by describing the most common of the machines in general use an adequate idea of cold-heading machinery will be given, as the general operating principles are similar.

E. J. Manville Single-stroke Solid-die Cold-header

The single-stroke solid-die header is undoubtedly the simplest of all, and for that reason has been selected for the initial description. This machine is built in six sizes; the smallest size handles wire up to 1/8 inch diameter and the largest, which is the machine illustrated in Fig. 16, handles wire up to 1/2 inch diameter. The frame is of very heavy section and the crankshaft, which is of large diameter, is made of forged nickel steel. The bushings which support this crankshaft have their bearings close to each side of the crankpin so that there is little danger of bending the crankshaft by the heavy work required in cold-heading. The wire is fed in from the front of the machine through the usual type of grooved roll and is lubricated by a reservoir below the lower feed-roll. The cut-off is operated from the side in the manner described in the previous chapter, and on this machine a safety connection is provided between the crank and cut-off cam slide. This is in the form of a shear pin so that if excessive load is placed upon the cut-off knife the machine will stop without doing damage other than shearing the safety pin. A patented form of cut-off knife is employed so that the blank will be held rigidly while being sheared and thus cut squarely. This is an essential feature on single-stroke machines, for as there is no preliminary or coning blow to centralize the stock, it

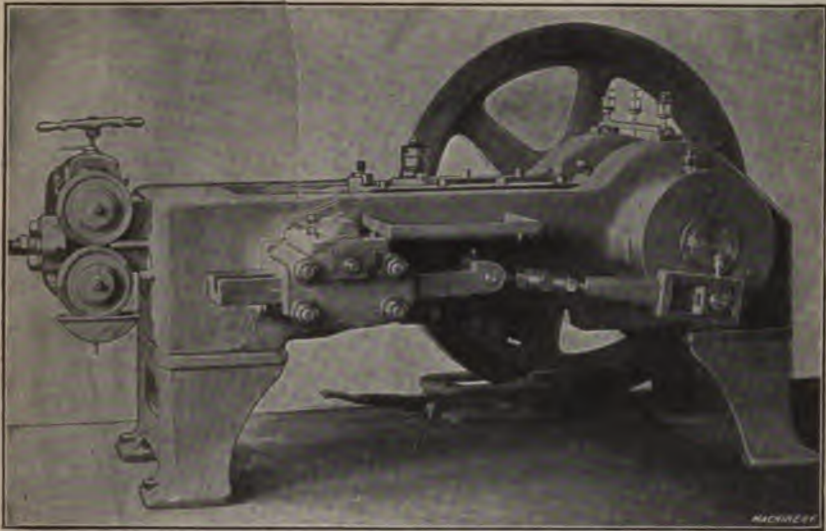


Fig. 16. Single-stroke Solid-die Cold-header—E. J. Manville Make

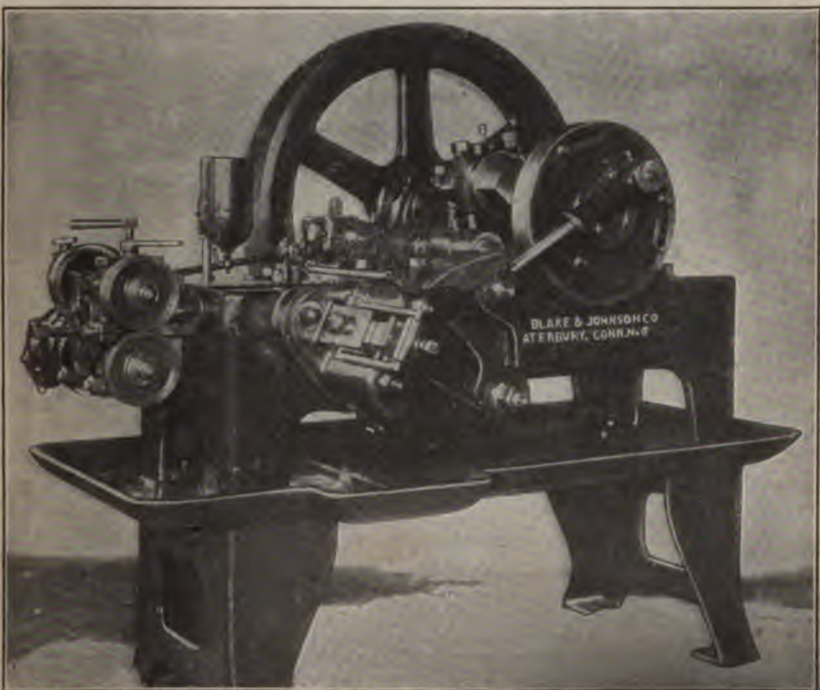


Fig. 17. Double-stroke Solid-die Cold-header—Blake & John·

must go to the dies in good condition after being cut off. The balance wheel is very heavy in design, and as it is essential that a heading machine be stopped at some point other than the center, a foot brake, shown in Fig. 16, is provided, so that the wheel may be stopped at any desired point in its revolution.

Single-stroke headers of the open-die type are not very largely used except in the wood-screw industry. The main point of difference between this type of machine and the one previously described is the die-operating mechanism, and this mechanism was described in general in the preceding chapter.

Blake & Johnson Double-stroke Solid-die Cold-header

Fig. 17 illustrates a double-stroke solid-die header made by the Blake & Johnson Co. of Waterbury, Conn. This machine is one of the latest of its class and has some radical differences which are worthy of description. This is the first header to be made with a pan or tray between the frame and legs. In addition to catching dripping oil and odd ends of wire it furnishes a shelf for catching the finished work. This form of construction results in a more rigid machine than any of those types where long slender legs are employed. By observing the cut-off cam-slide mechanism at the center of Fig. 17, it will be seen that the cam groove is cut in the face of a segment rather than in a slide. This segment is pivoted on a stud as shown, and it is claimed that less power is required for its operation; in addition it makes a more compact arrangement. The connecting-rod which operates the cut-off cam is held by clamping at its operating end and when this clamp is set to the proper tension to do the work it acts as a safety device, allowing the connecting-rod to slip if excessive strain is placed upon it. The distinguishing feature between single- and double-stroke machines is the rise-and-fall motion which must be used for raising and lowering the punch-block so that the two punches strike alternately on the head of the wire blank. The mechanism that provides for this is the Ingraham rise-and-fall motion which was fully described in the previous chapter. This type of mechanism has the advantage of being located at the top of the machine where it is most accessible and convenient to adjust.

On this machine lubrication is provided for by dripping oil from a cast-iron pot that is mounted on a stud at the head of the machine. From this pot the oil drips to a hole in the bed over the wire line from which it drops on the wire just before the latter enters the dies. Lubrication is an important feature on cold-headers especially when annealed steel or iron wire is being worked, because the lime film which remains from the annealing operation renders the wire hard to eject unless lubricated. The feed is operated by the three-pawl system so that the finest adjustments of feeding lengths may be obtained. The crankshaft bearings are cored out and provided with chain oilers, which are a new feature on cold-headers. The capacity of this machine is the heading of blanks 3/16 inch diameter up to 1¼ inch length under the head.

Waterbury-Farrel Double-stroke Solid-die Header

One of the most popular of the double-stroke solid-die headers is that made by the Waterbury Farrel Foundry & Machine Co., Waterbury, Conn. The machine is made in one- and two-cycle types, shown in Figs. 18 and 21, respectively. Both of these machines are of the toggle-operated type; the operating principles of one- and two-cycle headers were explained in Chapter I, "Principles of Cold-heading." The machine illustrated in Fig. 18 is the No. 0 size and has a capacity for heading

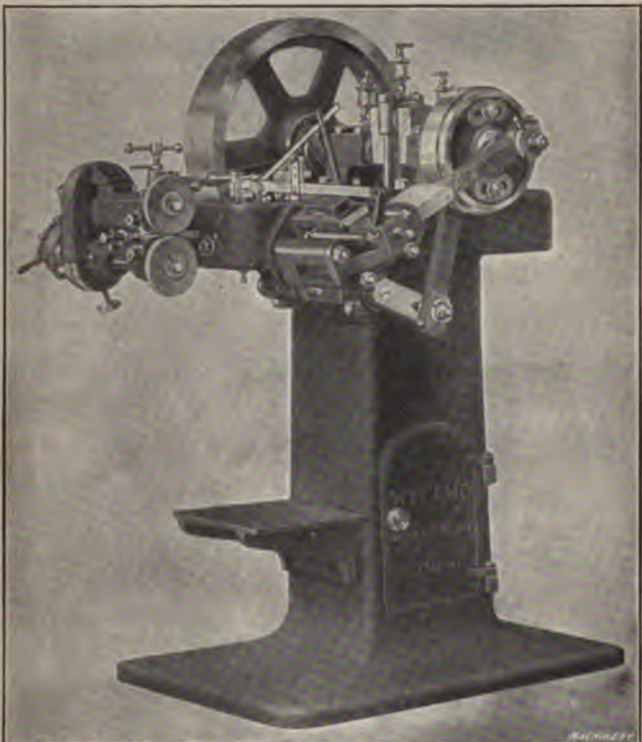


Fig. 18. Double-stroke Solid-die Cold-header, One-cycle Type—Waterbury Farrel Foundry Make

wire up to and including one-eighth inch in diameter. It is designed to handle wire rivets or blanks up to one inch in length, under the head, this being the largest amount of one-eighth inch wire that can be easily ejected from a solid die. This machine has been highly developed and embodies all the latest improvements in heading machinery. On account of its being of the one-cycle type, striking two blows to each revolution of the flywheel, the machine can be run at a comparatively slow speed and still obtain a large production. As is usual in solid-die machines, the wire is fed through feed rolls and [illegible] and brings up against a rigid feed-stop so that the len[illegible] arbitrarily determined. The cut-off bar is of the usual type carrying a cut-off blade at its end and in most instances the cutting off and carrying is done with the aid of a "fiddle-bow" carrier.

This fiddle-bow carrier, perhaps, needs a word of explanation, and for that reason is shown in detail in Fig. 19. The purpose of this type of carrier is to back up the cut-off blade when severing the wire and assist in transporting the blank to the heading die. In Fig. 18 a view of the fiddle-bow carrier may be seen. From this, in connection with Fig. 19, which is a view of the die end of the machine from the inside, it will be seen that the mechanism consists of a carrier *A*, supported in a bracket *B* at one end, pivoted and actuated by end bracket *C* which is bolted to the end of the cut-off slide. At the operating end of carrier *A*, an arm *D* is pivoted, being normally kept in its uppermost position through a

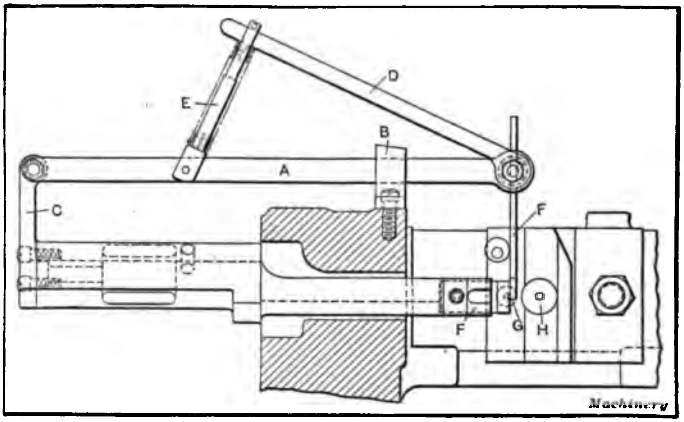


Fig. 19. Construction of the "Fiddle-Bow" Carrier

spring-encircling rod *E*. This rod is slotted at the upper section so that the arm *D* is free to move up or down. Finger *F* is the active part of this carrier, and when the wire emerges from the cut-off quill *G*, this finger is on the opposite side from the cut-off blade, being held there by pressure of the spring located on rod *E*. When the cut-off blade advances, the wire is prevented from being deflected at its outer end under the cutting pressure and is held perfectly square while the cut is being made. Now when the cut-off blade advances with the blank toward the heading die *H*, the fiddle-bow carrier mechanism also advances through contact of bracket *C* with carrier *A* which slides through supporting bracket *B*. After it is in the heading position and the blank partly has entered into the die, the cut-off slide returns and finger *F* of the carrying mechanism snaps back over the wire and brings up against the new length of wire which has advanced through the cut-off quill *G*. The advantage in using this type of carrier is that the wire is supported behind the cutting action and a square end of the blank is the result. This is important, for if the cut is not square, the head of the finished product will be "lop-sided."

The heading operations are actuated by the well-known powerful knuckle-joint mechanism, of which the Waterbury Farrel Foundry Co. are exponents, and as was explained in the preceding chapter, the one-cycle type is characterized by the striking of one long stroke and one short stroke of the heading slide as contrasted with two strokes of even length in the two-cycle type. The relative length of the two strokes may be governed by the design of the toggle mechanism, and it is customary to strike the long blow which does the coning or bulbing first. The second blow, which completes the heading, is taken care of by the short stroke; the reason for this is that concentrating the same amount of power into a short stroke gives a more powerful heading effect—just what is wanted for the final setting of the wire. On this make of ma-

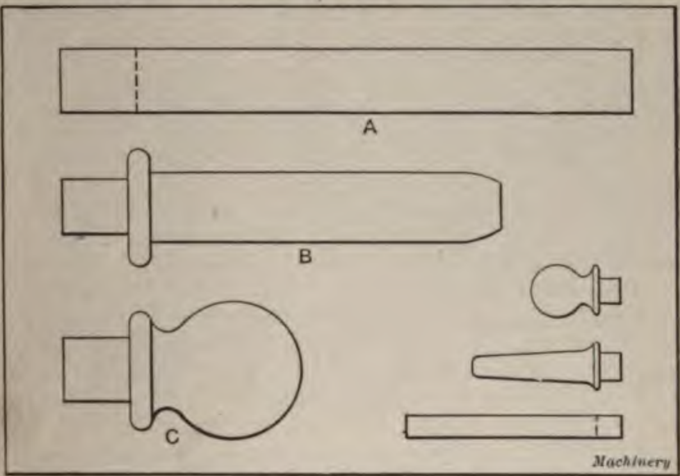


Fig. 20. Typical Examples of Reheading requiring an Open-die Machine

chine, the heading slide has ample wearing surfaces and is gibbed for taking up wear.

The toggles, upon which so much depend in this class of machinery, are made of a special grade of bronze with adjustable steel side plates for taking up wear. The connecting toggle-pin is, of course, of tool steel, hardened and ground. One important feature of the toggle construction is that the machine can easily be brought "off centers" by hand, in case it should get stuck while operating upon a damaged blank or on account of excessive pressure. This construction also makes the setting of the tools easy when operating the machine by hand. The feed mechanism is of the usual type with two grooved cast-iron feed-rolls through which the wire passes. Cast-iron rolls are used as it has been found that the wire slips less than when steel rolls are employed. By means of a pawl-arm operated from an eccentric on the crankshaft, the length of the feed can easily be a[illegible]ed even though the machine is in motion. The cut-off is opera[illegible] slide which may be seen at the right of the mac[illegible] operates back and forth through the cut-off bracket, thus actuating the cut-off blade. A safety slip device is provided so that if excessive strain is brought against the cut-off blade, the blade will not be broken, but will be stopped in its action by the slipping of the safety mechanism. The punch-shifting mechanism is positive, the punch-slide being shifted both in its up and down position against stop-screws so that they will surely be in line when the respective blows are struck. Adjustment is provided so that the punches may be moved sidewise, up or down, or longitudinally. The longitudinal adjustment is obtained from a broad wedge in back of the toggles at the end of the frame. The knockout is located in the end of the bed and ejects the work from the die by means of a lever that pivots in the feed-roll bracket, operated from a cam on the crankshaft. The entire thrust of the heading blow is taken on a stop-screw which backs up the knockout pin and accurately determines the correct length of rivet made.

Double-stroke Solid-die Geared Header—Two-cycle Type

The Waterbury Farrel Foundry Co. also makes a solid-die double-stroke header of the two-cycle type, and Fig. 21 shows the No. 3 size of this machine. It has a capacity for heading three-eighths inch rivets at the rate of fifty-five per minute. This is a geared machine of great power, and it requires two revolutions of the crankshaft to produce each rivet, in accordance with the two-cycle principle. This means that the feeding, cut-off and ejecting mechanism is geared down so that these functions operate only once while the heading slide is making two strokes. While this machine is more powerful than the one-cycle type, it is, of course, slower in its action, and the crankshaft and toggle mechanism must go through twice as many motions to produce a rivet as was the case in the one-cycle type. As in the previously described machine, the wire passes through the feed-rolls and cut-off quill and brings up against the feed-stop. The cut-off blade is actuated in connection with the fiddle-bow carrier which holds the blank to the cut-off blade and assists in carrying it to the heading position in line with the die. The upper heading punch strikes the first blow, forcing the blank into the die and centralizing the wire preparatory to the second blow which is struck by the lower punch, thus forming the finished head. The heading slide then draws back and the punches are shifted down ready to operate on the next blank.

The crankshaft is of large size and runs in bronze lined bearings on the larger machines. The flywheels, of which there are two on the large size machine, are held to the crankshaft between friction disks which slip and prevent damage to the machine should undue strain be imposed. The toggles on the machines are made of the best grade of cast iron, and provision is made for taking up the wear. The feed and cut-off mechanism are the same as in the type of machine previously described, and a safety shear pin is provided so that should the heading die become loose and project out far enough to prevent the cut-off knife from passing, or should the cut-off knife be obstructed from any

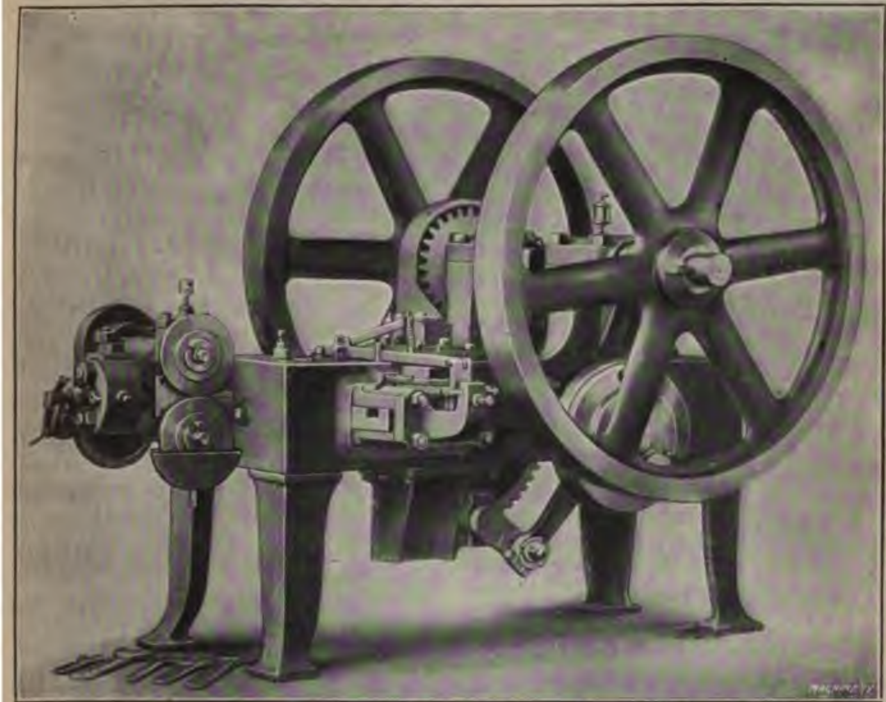


Fig. 21. Double-stroke Solid-die Cold-header, Two-cycle Type—Waterbury Farrel Foundry Make

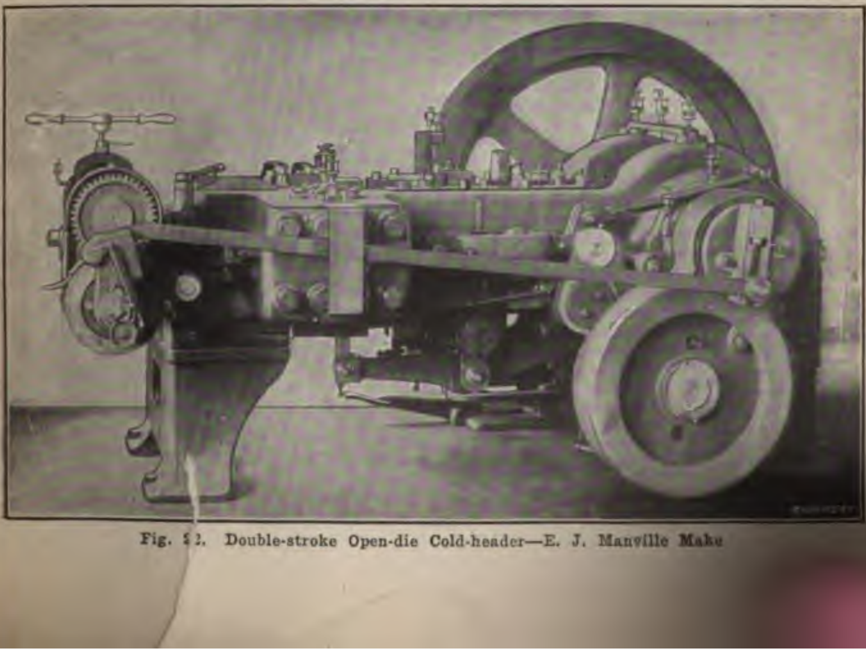


Fig. 22. Double-stroke Open-die Cold-header—E. J. Manville Make

other cause, the safety shear pin will be severed, causing no other damage to the machine. This shear pin is a plain straight piece so that it is a simple matter to insert a new one.

A relief motion can be furnished for this machine if desired. It consists of a mechanism that allows the knockout pin, against which the blank is forced during the heading operation to draw back after the blow is struck. This allows the metal to flow into the dies more freely on the second blow, and is especially desirable on such work as requires squares or shoulders underneath the head. By a proper knowledge of the use of this relief motion, a great many difficult jobs of heading can be accomplished with facility.

E. J. Manville Double-stroke Open-die Cold-header

Double-stroke cold-headers of the open-die type are the most complicated of the ordinary run of heading machines, for in addition to the rise-and-fall motion for operating the punch block, provision must be made for opening and closing the dies. In Fig. 22 is shown the E. J. Manville double-stroke open-die header. This machine is made in four sizes; the one illustrated is the No. 4 machine which handles wire up to one-half inch diameter. This header is of the crank-operated type, and the wire enters through feed-rolls of the usual type and thence to its cut-off position between the square dies. The dies are then forced sidewise, shearing the wire and carrying the blank over to the heading position. When in line with the backing block, the first or coning punch centers and partly heads the wire, leaving it in condition for the second punch to finish the work. On this machine the punches are locked automatically in both up and down positions while the blows are being struck. Another distinguishing feature of this machine is that the wire feed is operated from the right-hand side of the machine as may be seen in Fig. 22. This leaves the front corner of the machine on the wheel side free from all mechanism so that the operator can observe the working of the tools easily.

The feed-pawl operates only at every second stroke of the machine, for it will be remembered that this is a double-stroke machine. By means of a handwheel which may be seen opposite the lower parts of the ratchet feed wheel a quick and accurate setting of the pawl may be made and it may be regulated while the machine is running. The wire feed is easily started or stopped by a hand lever.

A safety connection is provided between the die-operating cam and the crankshaft, in which there is a cast-iron plate. Should any obstruction prevent the dies from closing, this cast-iron plate will break and drop to the floor, thus instantly disconnecting the crank and cam-slide. An automatic throw-off instantly stops the wire from the feed when this safety device is brought into play. This machine is also provided with a foot brake to assist in stopping the header at the proper point.

Waterbury-Farrel Double-stroke Solid-die Reheader

The varieties of reheaders are almost as numerous as all the other *types* of headers combined. The most common types, however, are the single- and double-stroke machines of solid- or open-die types. A representative machine of the double-stroke solid-die type is illustrated in Fig. 23 which shows a machine made by the Waterbury Farrel Foundry & Machine Co. This machine takes partly headed rivets or screw blanks after they leave the heading machine proper, and by means of a hopper feed, the blanks are automatically fed to the die in the reheader, thus making the operation entirely automatic. Automatic hopper feeds are of different types, but the usual form consists of a hopper into which the blanks are thrown promiscuously. They are caught by their heads in a blade which has a slot at the top, slightly wider than the body of the blank. This blade rises vertically through the center of the hopper, and as it passes through the mass of blanks, some are sure to be caught

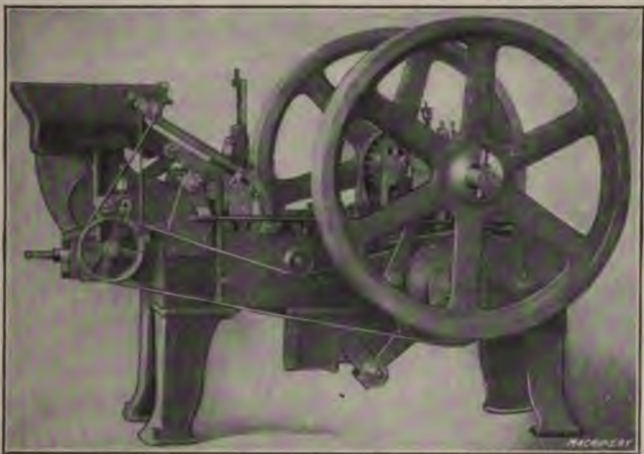


Fig. 23. Double-stroke Solid-die Reheader—Waterbury Farrel Foundry Make

by their heads and are carried to the uppermost position, where there is an extension of the slotted inclined chute. The blanks slide down this chute, which may be seen between the hopper and the flywheel, Fig. 23, and a guard which passes over the heads of the blanks prevents any which are not in the proper position from passing. A transfer slide on a line with the dies supports a pair of fingers that pick a blank from the carrier slide and deliver it at the proper time to the heading die where punches do the reheading. The operation of the heading mechanism is practically the same as that of the standard heading machines; in fact some of the types of standard heading machines can be fitted with reheading attachments. To do this it is necessary to take off the cut-off slide and substitute a transfer slide for conveying the blanks to the die. The reheader here shown has a capacity for handling ⅜-inch wire, producing from 50 to 60 rivets per hour.

Cold-heading Operations

After describing the different types of cold-heading machines, the next step is to take up the work for which each type is best ad-

By the process of elimination we can dispose of the open-die types of machines with the simple statement that, if the blank to be produced is over nine or ten diameters of the wire in length under the head, it must be made upon an open-die machine. There are, of course, exceptions to this rule, but they are so special that they need not be considered here. In general, open-die machines are faster than solid-die machines of the same size, as the open-die cut-off mechanism is simple and much more rapid in its action. A rivet or screw-blank made on an open-die machine is easily distinguishable by light raised lines under the head and along opposite sides, caused by the metal being crowded into the crevices between the dies when the heading pressure separates them ever so slightly. The tools used in the open-die machines are more costly to make, and each set is good only for one particular length of rivet. In speaking of the wire in units of diameter, all sizes are included under the general rules. Thus, while only 1¼ inch of ⅛-inch wire can be ejected from a solid die, 3¾ inches would be the limit when working ⅜-inch wire. Similarly, when heading in the single-stroke machines, two and one-half diameters of any size of wire is all that can be put into a head.

Single-stroke Heading

Excluding reheading, we have only the single- and double-stroke heading to consider, since the heading operation on solid- and open-die machines are the same. It has been stated that the limit which may be reached with a single-stroke cold-header is the upsetting of two and one-half diameters of the wire into the head. By this we mean that no matter how soft the wire is, nor how carefully it is cut off, an unsupported length of two and one-half diameters irrespective of the size is all that can be controlled by a single heading punch. If a larger amount of wire is left unsupported and struck by the heading punch it will buckle at the center and be forced over to one side. A typical single-stroke solid-die heading job may be seen at *A*, Fig. 24. The upper illustration shows the wire blank and the lower view the finished piece. At *B*, to the right, is a similar single-stroke heading job, but one which requires an open die machine on account of its length. Now, turning to Fig. 26, the action of the metal under the heading operation may be followed. In the upper illustration the blank is represented with the metal for the head, comprising two diameters, extending from the die. The four illustrations which follow are intended to convey an idea of the way the metal spreads under the advance of the heading punch. The heading punch is, of course, in this case recessed to shape the fillister head to be given the blank. It will be seen that we have here the same result as was obtained in our preliminary experiment with the hammer in the first chapter. The metal, when first under pressure, commences to bulge next to the die and continues spreading out until confined by the limits of the recess in the punch. At the right-hand side of Fig. 26 we have a similar single-stroke heading operation taking place on a wire blank which was too long to be headed in *a solid die*. In this instance the head was oval, countersunk in shape and two and one-half diameters were upset in the head. This represents practically the limit of a single-stroke heading operation. The flow of the metal is represented by the four illustrations within the brace, and the lower view shows the completed blank in the die ready for ejection.

Double-stroke Heading

It is on double-stroke heading operations that we find the most interesting as well as the most difficult work. Referring to Fig. 24, a

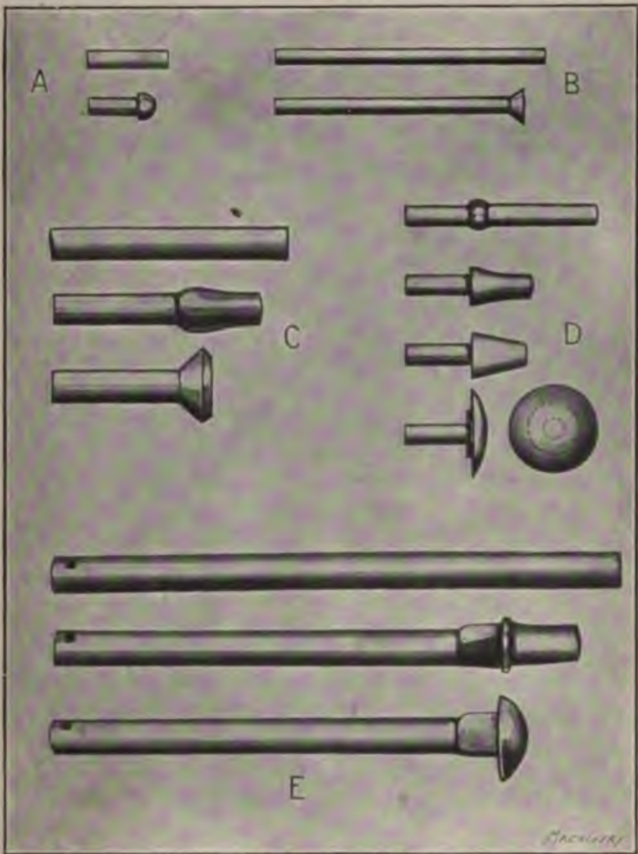


Fig. 24. Examples of Cold-heading from Different Types of Machines

double-stroke solid-die product may be seen at *C*, and at *E* a double-stroke open-die product. The only reason for using the open-die machine for producing the work shown at *E* is on account of its length. The head in itself could just as well have been produced on a solid-die machine of the double-stroke type.

In all double-stroke heading operations the first blow, known as the coning blow, is used for centering and starting the heading ...

tion, and leaves the wire in condition to be readily finished by the second blow which does most of the work. Referring again to *C* in Fig. 24, the upper view shows the wire cut off, and in the center is shown the result of the coning blow. The punch which does the coning is shaped so as to "gather" the stock, tapering it at the end and allowing it to partially head next to the die, so that when the second blow

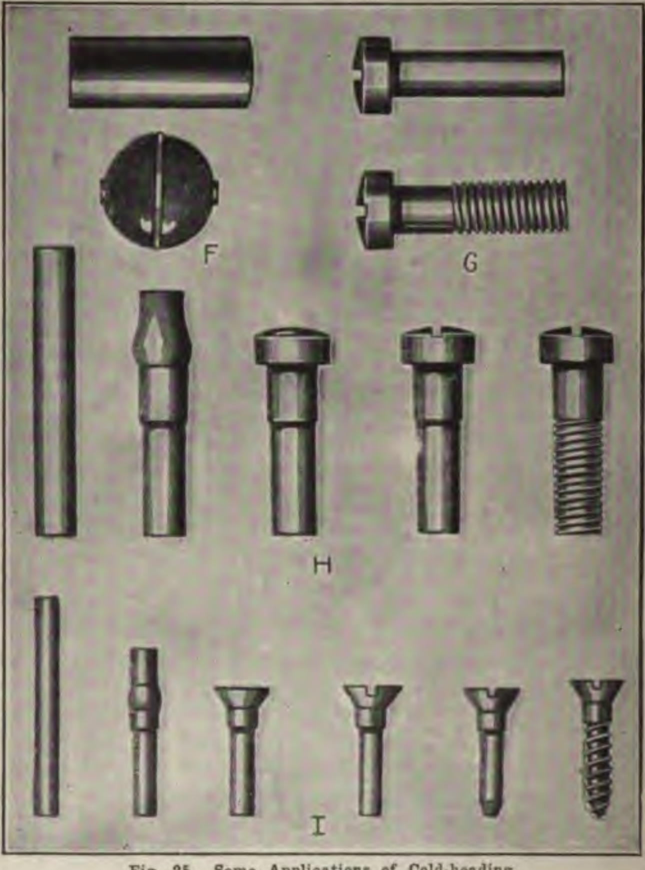


Fig. 25. Some Applications of Cold-heading

is struck the metal will flow naturally toward the desired shape. When the blank is cut off the end is apt to be "out of square" which, of course, means that more metal would be on one side of the head than on the other, and if struck without being centered, the result would be a "lop-sided" head. The limit of the double-stroke heading machine is the upsetting of five diameters of the wire. On certain grades of metal and by using extreme care this rule may be slightly exceeded, but a five-diameter head is very nearly the limit possible. In Fig. 27, at the upper left-hand corner, may be seen the wire blank which has been cut off and is in the die ready for heading. In this instance there are three and one-half diameters of the wire left projecting from the die to be upset into the head. Directly below this may be seen a view which shows the result of the first or coning punch. The four views which follow show exactly how the wire upsets in forming the head, until at the extreme bottom is shown the completed blank, ready for ejection. On the right-hand side is shown the same series of views to illustrate the making of the head of a wagon bolt, which, because of its length, was made on an open-die double-stroke machine.

Many heading jobs are performed upon a double-stroke machine that would seem to come within the range of the single-stroke machines.

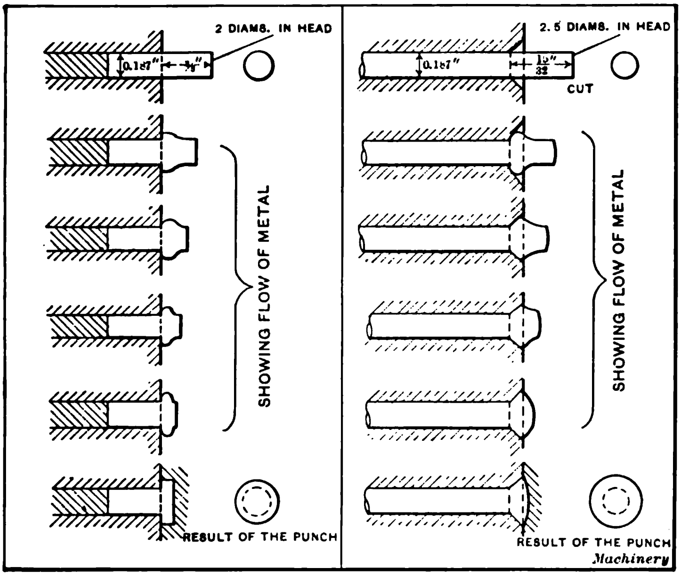


Fig. 26. Evolution of Screw Blanks made on Single-stroke Cold-headers

The reason for this is that with the double-stroke machine the metal can be controlled to a higher degree of accuracy, and for that reason on accurate work the double-stroke machine is often used even though the head requires less than two and one-half diameters of the wire.

Fig. 25 is shown to illustrate some practical applications of cold-heading. At *F* is shown a blank and a headed ball, such as is used in the ball bearing industry. Heading machine manufacturers have given special attention to the heading of steel balls, so that cold-heading is now the usual way of producing ball blanks. At *G* is shown a screw blank and a rolled thread screw, which illustrate a condition of thread rolling practice. When the screw thread[illegible] be rolled, and it is still desirable to have the unthreaded [illegible] the same diameter as the threaded section, [illegible] shown at *H* must be followed. In this sect steps in making a rolled thread screw of uniform size are shown. First we have the cut off blank; second, the partly headed blank in which the section which is to be left unthreaded has been upset enough larger to match up with the diameter of the thread which will be rolled upon the lower section. The completely headed blank is shown next, then the slotted head, and last, the finished screw with the rolled thread. Similarly at *I* are shown the successive steps in making a wood screw, and the manufacture of machine and wood screws like those shown forms one of the most extensive uses for cold-heading machinery.

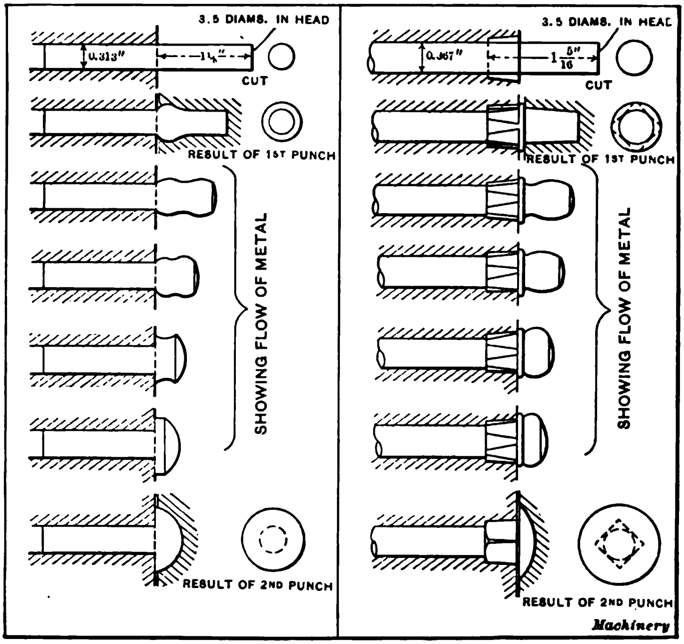


Fig. 27. Evolution of Screw Blanks made on Double-stroke Cold-headers

Reheading

Reheading is a more important branch of cold-heading than is generally recognized, and some of the "stunts" which may be accomplished with the proper knowledge of reheading machinery strongly emphasize this fact. Reheading is usually necessary for one of two reasons; either to produce a head which would require too much work for the double-stroke machine to do, or to produce a head which is larger at the end than at the shoulders as in the case of hinge pins like those shown in Fig. 20. Even though the blanks are usually annealed before going to the reheaders, this operation is one which requires a great deal of force because the metal has already been compressed and is very dense before being reheaded.

A good example of reheading work is shown at *D* in Fig. 24. The first two pieces represent the work of the double-stroke solid-die heading machine, and from this point, the blanks are handled in a double-stroke solid-die reheader. The third illustration from the top in this group shows the result of the first reheading operation, and a plan and side elevation of the completed piece is shown beneath. The diameter of the head is very great, as compared with the diameter of the shank of the rivet and it will be readily appreciated that four operations were necessary to keep the metal under control and completely head the piece.

For producing hinge pins like that shown in Fig. 20, an open-die reheader is necessary. This is really a very interesting job of cold-heading, as there are eight diameters of the wire in this head. Two operations are necessary to bring the blank *A* into the position shown at *B* and these operations are performed upon a double-stroke header. After this point, the partly formed blanks are annealed and finished in a double-stroke open-die reheader, producing the result shown at *C* in two additional operations. The hinge pin shown at the right-hand side is similar but smaller.

CHAPTER III

COLD-HEADING DIES AND TOOLS

In the first two chapters the principles and different types of cold-heading machines are treated, together with the character of work for which each machine was adapted. In this chapter we will consider in detail the tools for solid- and open-die machines, including an outline of the operations connected with their making. As there are numerous little kinks and methods followed by individual heading die makers, it will only be possible to strike an average and outline the general processes of making the tool. As in other lines of tool-

Fig. 28. A Pair of Solid Dies for the Cold-header

making, no two workmen's ideas on a given set of tools will agree, although each may be right from his own point of view.

Tools for cold-heading machines may be roughly divided into two classes—those used in solid-die machines and those used in open-die machines Whether the tools are for a single- or double-blow machine affects only one extra tool, namely, the upsetting or coning punch. In all other respects the tools are similar. The chief difference between the tools for the solid-die and open-die machines lies in the dies themselves, the punches being the same in both cases. Figs. 28 and 29 illustrate the difference between dies for the solid- and open-die machines. Fig. 28 shows a die and punch for a solid-die machine. These tools are very simple, being merely sections of round stock, the die being made with a hole to agree with the diameter of the wire, and the punch with a cavity of the correct shape for forming the head. In Fig. 29 a pair of open dies, without the punch, is illustrated. In this case the wire is held between the halves of the die, and the cutting off is done by the dies themselves, as was explained in Chapter I. Therefore a pair of dies for the open-die machine must be of exactly the same length as the finished rivet under the head. The dies shown in Fig. 29 were made for forming a carriage bolt having a square shoulder under the head. By referring to Fig. 30, a set of tools for a solid-die machine may be seen in place. These consist, in the case of a single-blow machine, of the die *A*, in which the wire blank *B* is held for heading; the punch *C* which shapes the head and is actuated by the ram of the machine; the cut-off die or quill *D*, which is similar to the heading die, having a hole through its length through which the wire is fed against a feed-stop (not shown) the proper distance, and is then cut off by the cut-off blade *E*. The face of the cut-off die is crowned to help the cut-off blade do its work. Mounted on the cut-off blade is a carrier *F* that holds the blank to the cut-off blade so that it may be carried over to the heading die. A

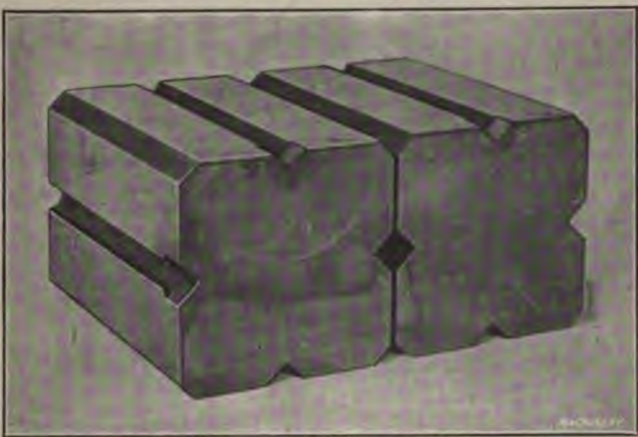


Fig. 29. A Pair of Open Dies for the Cold-header

backing pin *G* fits in the hole in the heading die and regulates the length of the rivet under the head; it also serves as an ejector after the rivet has been finished. In Fig. 33 may be seen a set of heading tools, with the exception of the cut-off quill. These particular tools were used in making a round-head screw that required two blows to form the head. The die is shown at *A*; the second-operation punch at *B*; the first-operation punch at *C*; the backing pin at *D*; and the cut-off blade without the carrier at *E*. At *F* may be seen the cut-off blank; at *G* the coned blank resulting from the first operation; and at *H* the finished round-head screw. If this same work were to be done in an open-die machine, the cut-off blade and the backing pin and die would be eliminated and a pair of open dies substituted.

Making a Solid Die

At first glance, the solid die appears to be simply a round piece of stock with a hole extending through it to receive the wire. There are, nevertheless, many points to be considered in making this die, and without the knowledge of them the tools would never work satisfactorily. The heading dies, punches and cutting-off tools are made from a good grade of tool steel, annealed stock being preferred. The tools are sometimes made of low carbon steel and then carbonized, and at least one large user of heading machines follows this method exclusively, but unless the best of carbonizing and hardening facilities are available it would be inadvisable.

The length and diameter of a heading die are governed by the size of the machine in which the die is to be used. An idea of the proportion of the diameter to the length may be obtained by stating that

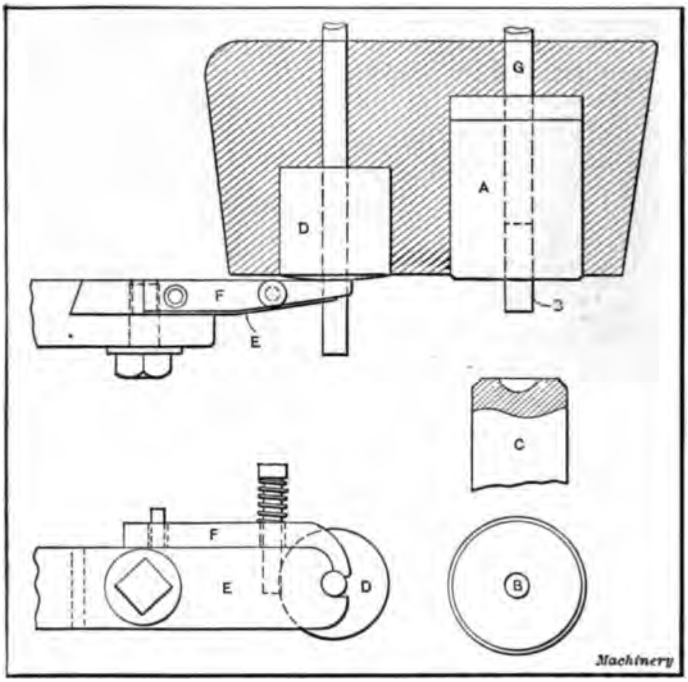


Fig. 30. Section of Cold-header showing Locations of Principal Tools

for handling wire up to 1/8 inch diameter, a die of 7/8 inch diameter I 1 3/8 inch long agrees with good practice, and for handling 1/2 inch wi the die may be 3 3/8 inches in diameter by 4 1/2 inches in length. Th dimensions are not arbitrary, but are, of course, determined by ' make and size of the machine in which they are to be used. In I 35 is illustrated a little kink by means of which considerable die-s may be saved. In this case a backing block is made to replace a' one-third the length of the die. The dies themselves may thu made correspondingly short, and as this pillar block is used ber each die, one-third of the steel of each heading die is saved.

Fig. 31 shows, in section, a typical heading die of the solid just made and ready for hardening. This die is given with actual dimensions so that the shrinkage allowances may be duly noted. The length of the die is 1⅜ inch and the diameter ⅞ inch, and it is to be used for heading rivets from 0.105 inch wire. First, a hole a few thousandths under 0.105 inch diameter is drilled through the die. The die is then relieved from the back for a short distance with a No. 33 drill, enlarging this section to 0.113 inch. A tapered reamer which has a taper of about 0.003 inch to the inch is then used to ream out the unrelieved section very nearly to the face of the die. At this point the die is hardened and this operation causes the mouth of the die to "open," leaving it about as shown in Fig. 32. Using emery and oil, the die is then lapped out from the back until the hole measures

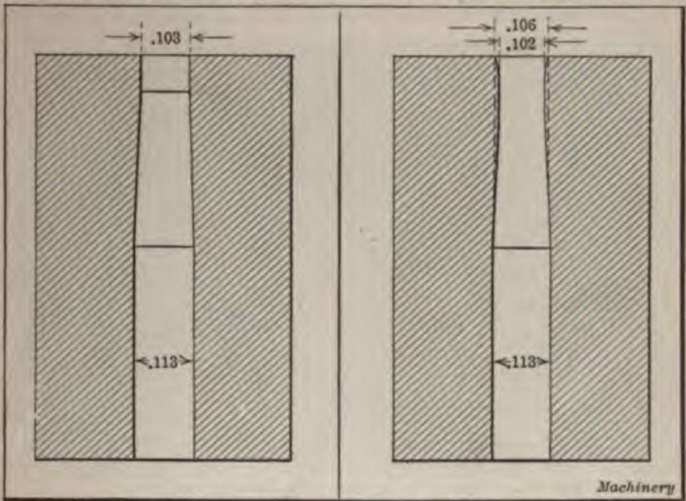


Fig. 31. Section of Solid Die, with Allowances for Hardening

Fig. 32. Section of Solid Die showing Shrinkage in Hardening

0.106 inch diameter, this being 0.001 inch over the diameter of the wire, allowing plenty of play for the working of the stock.

The hardening operation is comparatively simple, the requirements being to have the die, especially the section adjacent to the hole, very hard. A useful kink to be followed in securing the desired hardness is illustrated in Fig. 44. This consists of a funnel shaped bushing which is threaded so that it may be screwed onto the ordinary water faucet. The die is brought to the right heat and held under this conical bushing and the water turned on full force. When the water is turned on, the face of the die and the hole receive a sudden quenching, giving it the extreme hardness that is necessary.

The Punches

Before a punch can be correctly made for any rivet except a "flat-head" a counterbore is necessary to obtain the exact shape of the cavity. In the case of flat-head screws or rivets, the punch consists simply of a length of round steel having a perfectly flat face with chamfered edges. With round or fillistered head blanks, however, the finish punch must contain a cavity of the exact size and shape of the head. In making a punch like that shown in Fig. 33 for a round-head rivet, a reamer of the same semi-spherical shape is necessary. The reamer is turned up in the lathe, leaving a flat shoulder to limit the depth of the cut. The "half-type" reamer is employed, and is relieved only for a short distance behind the cutting edge so that a good bearing is secured while the punch is being reamed, resulting in a smoothly finished cavity. In hardening these reamers they are drawn to a straw color. In the case of difficult shaped heads, it is often found advisable to hammer a piece of lead into the soft die so that measurements may be taken and checked up with the sample. Weight forms an important feature in determining the amount of metal which

Fig. 33. A Set of Heading Tools and Work from a Double-blow Cold-header

goes into the head. In setting up the machine, for instance, the toolmaker will often compare the weights of his rivet and the sample in order to see if the right amount of stock is being used. By cutting off the head close to the shoulder and weighing it, he can determine the amount of stock required, and by balancing the head with an equal weight of wire stock, he can readily determine the distance to which to set the wire feed.

In the case of double-blow machines, in which an upsetting or coning punch is used, there seems to be no definite rule that can be laid down for the shaping of the cavity in the coning punch. As before explained, the idea of the coning punch is to upset the metal and leave it in condition for the final distribution into the finished head. Generally speaking, this intermediate shape is that of a truncated cone, the base of which is very nearly the diameter of the finished head, and the length of which is about two-thirds the amount of wire advanced by the wire feed. The top of the wire is left approximately the same diameter as the blank and slightly rounded. If a very large amount of metal must be put into the head, the angle of the cavity in the coning punch is made as obtuse as possible.

It is customary to relieve the coning punch about as shown at *C* in Fig. 33, the object being to remove all danger of interference with the cut-off blade, because the coning punch strikes the wire blank just as the cutting-off blade releases it; therefore it helps matters to have the cut-off blade relieved as well as the coning punch. When the coning punch is to be used in connection with a countersunk die for flat-head screws, it is relieved about as shown in Fig. 38. By so doing, the wire in the cone is supported and driven down into the countersunk section of the die, instead of being left out at the line of the die face. There are so many governing factors bearing upon the shapes of coning punches that it must be left largely to the judgment of the

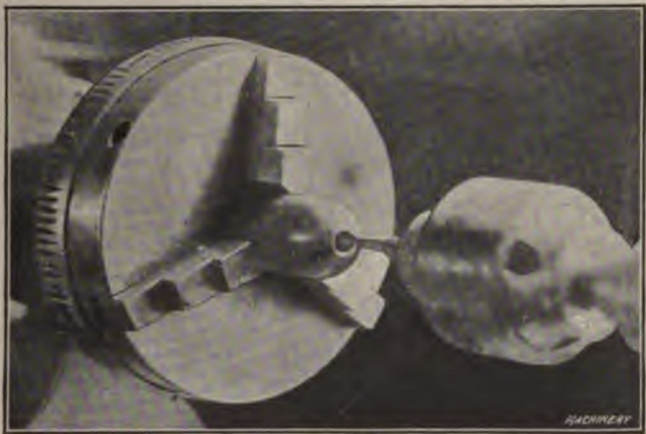


Fig. 34. Reaming out a Coning Punch

toolmaker. Punches for fillister head or other deep types of punches where the blanks would be likely to stick are often fitted with spring ejector pins as shown in Fig. 39. Ordinarily the die is the member in which sticking is most prevalent, but when the blank is short and the head is deep sticking will be encountered in the punch.

In the manufacture of very cheap screws, the slot in the head is often formed by the heading punch instead of being sawed. This means that the cavity in the heading punch must have a ridge of steel left standing to drive the metal down for the slot. To cut the cavity to this shape would be practically impossible; therefore the common practice is to hub the punch. The hub is made by turning up a blank of steel with a face of the same shape as the head of the screw to be produced. A slot is then milled or filed in the center of the head of the hub, after which it is hardened and drawn to a straw temper. Before being hubbed, the face of the heading punch is first convexed so as to leave the highest point at the center, thus providing enough stock to make a well formed cavity. The tendency is for the metal in the punch to sink away from the slot in the hub; therefore by ving an excess amount of metal at this point, the slot is completely .ed when the punch is hubbed. After being hubbed, the punch is ced off, of course, and the sides turned up for hardening. Fig. 36 ;presents the hub and the punch-blank before hubbing and Fig. 37 hows the hubbed punch before being faced off.

The Cut-off Tools

The cut-off die is simply a section of round stock having a hole extending through it slightly larger in diameter than that of the wire being worked. On small sizes of wire, 0.001 inch provides sufficient clearance. The face of this die is crowned slightly so that the cut-off blade which works in conjunction with it may act without binding on any other part of the die face. The cut-off blade is shown at *E* in Fig. 30, from which it will be seen that the end is filed out U-shaped, so as to partly enclose the wire, thus supporting it while the cutting-off

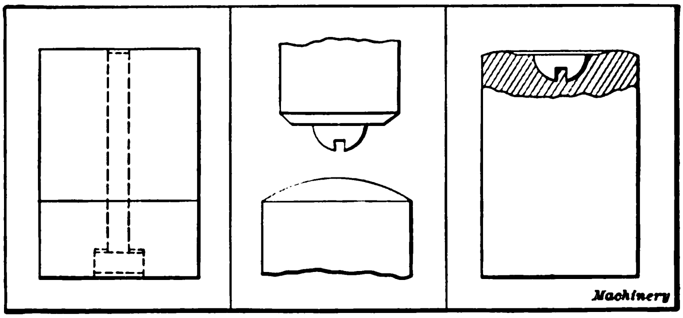


Fig. 35. A Kink for saving Die Stock | Fig. 36. A "Hub" and a Punch Blank | Fig. 37. Punch after hubbing

operation is taking place. A spring-finger *F* is fitted to the cut-off blade that snaps over the wire when the cut-off blade advances for cutting and holds the blank so that it can be carried to the heading die. There are different methods of applying the spring-finger or carrier, but a good way is illustrated in Fig. 30. Here the spring pressure is supplied from the spiral spring over the stud near the center, while the pin at the end operates in an enlarged hole in the finger serving merely as a guide to prevent the finger from swiveling. Both cut-off die and blade are hardened and drawn to a straw temper. There is little to be said about the backing pin which is shown at *D* in Fig. 33 except that as it receives the full force of the heading blow it must be hardened and drawn to a very dark purple.

Tools for Open-die Machines

The only explanation required for tools for the open-die machines the operations connected with the making of the die halves. The which are illustrated in Fig. 29, are made by shaping up square tions of tool steel to fit the die-holding block of the header. halves of the die are left large enough in size to allow for grinc ~nd down the center of each face is milled a half-round groove size slightly less than the diameter of the wire which is to be handled in the header. After the bulk of the stock has been milled out in this manner, as shown in Fig. 43, the halves are clamped in a special holder illustrated in Fig. 41 and a reamer of the proper size is run through the hole, taking half the stock from each die face. Set-screws are provided on the die-holding box to clamp the two halves together and take up end play while this operation is being performed. Each of the four pairs of faces is treated in this manner and, of course, they are marked so that they can be mated readily. The object of having all four faces grooved is simply to make use of the other three sides of

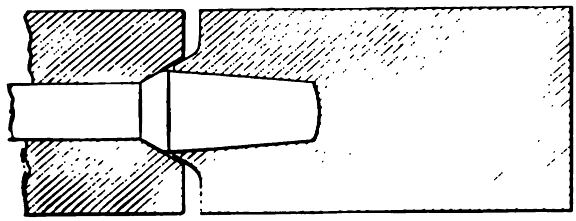


Fig.33

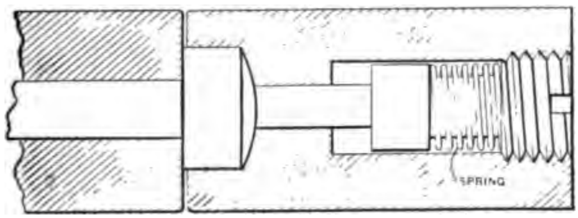


Fig.39

Machinery

Fig. 38. Coning Punch relieved to force Wire into the Countersunk Head of the Die. Fig. 39. Spring-pin in Punch which facilitates Ejection

the die; thus as soon as one pair of grooves has worn out of round, the dies are simply turned to bring a new pair of faces into use. As was explained in Chapter I, the object of chamfering the corners of the die halves is to facilitate the opening of the dies by the spring-finger on the machine. Fig. 42 shows the manner in which the square section of a die for producing a carriage bolt is machined. This square section comes under the head of the bolt and, therefore, must be provided for in the dies. After reaming out the grooves in the die faces the square outline is marked on each of the faces of the die, and the lines scribed for the depth. A starting point is made by chipping a groove at the proper distance from the face of the die, and the rest of the stock is removed by a square shaper tool, thinned down at the face to permit of its starting in the chiseled groove. Each of

Fig. 40. Drilling out a Solid Die

Fig. 41. Reaming a Pair of Open Dies

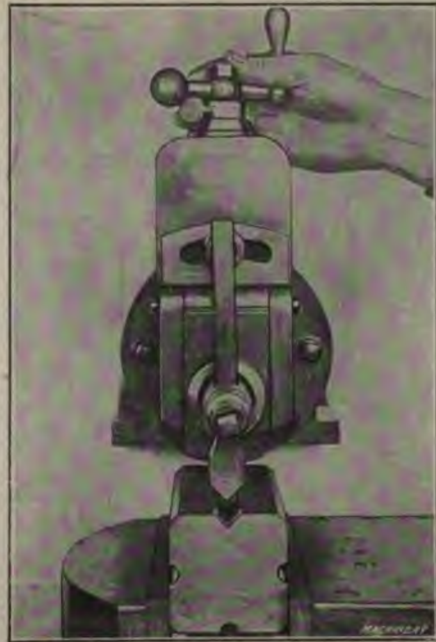


Fig. 42. Shaping Square Section in an Open Die

faces of the two die halves is similarly treated. As with solid dies, the open dies are hardened and the faces and es are ground before being put into use. It is very important that the faces of the dies be properly ground so that they will come close together and prevent the headed metal from bulging out in the form of fins on the sides of the work.

In grinding the sides of the die halves, the stock taken off permits the faces to come together far enough to flatten the circular opening in which the wire is held. This provides the necessary clearance for gripping the wire.

Multiple solid dies are often made for the sake of economizing in steel. Examples of such dies are shown in Figs. 45 and 46. The die in Fig. 45 has three openings so that after one of them has been worn out of round, the die may be moved along in the special holder necessary to hold a square block and another hole put into use. If the work is such that the die can be made without clearance, the block

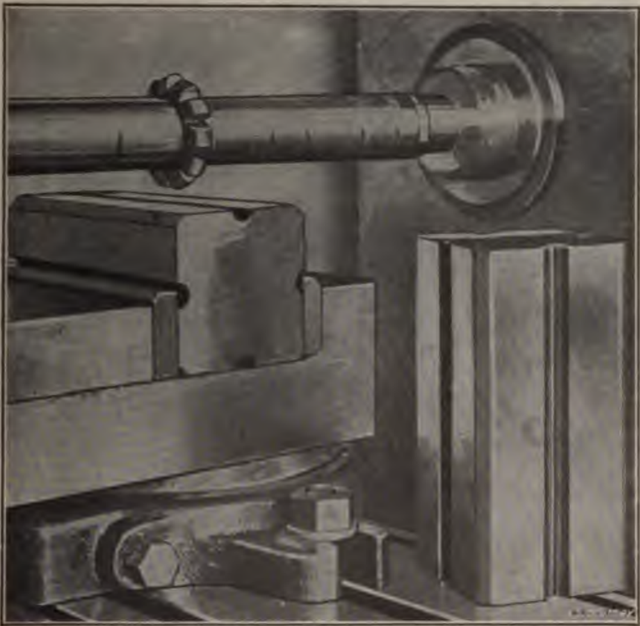


Fig. 43. Milling the Grooves in Open Dies

can then be reversed and the opposite ends of the three holes used. Similarly, in Fig. 46 is a multiple die of hexagonal shape, providing eighteen working openings. As a general rule, however, multiple dies are not used, because of the trouble caused by special die-holders. The plan of reversing the die to use the opposite end of the hole has disadvantages on some work where the heading blows close the hole insomuch that the necessary lapping out makes the method more troublesome than beneficial.

Setting-up for a Plain Heading Operation in the Header

In setting-up in a solid-die header, the first step is to put in the cut-off die and adjust the cut-off blade. The blade is adjusted by snapping the finger over the wire, and while thus held it is clamped in position against the cut-off die. The die is next bolted into its seat and the backing pin adjusted to size the length of the rivet under the head. The finish punch, in the case of a double-blow machine, is then located in the punch-holder. The coning punch is next held in the punch holder, and, if necessary, it is adjusted to bring its face into line with the finish punch. The finish punch should be set without backing or "shimming" of any kind, but if necessary the coning punch may be shimmed up to agree with it. The stroke is then adjusted so that the punch faces almost touch the die face. After this, the wire feed may be set and the machine is ready to be operated. On every job there is more or less adjusting of the feed, grip and ram movements to obtain the exact results.

In setting up the tools on an open-die machine there is, of course, no cut-off to be taken into consideration other than the proper setting

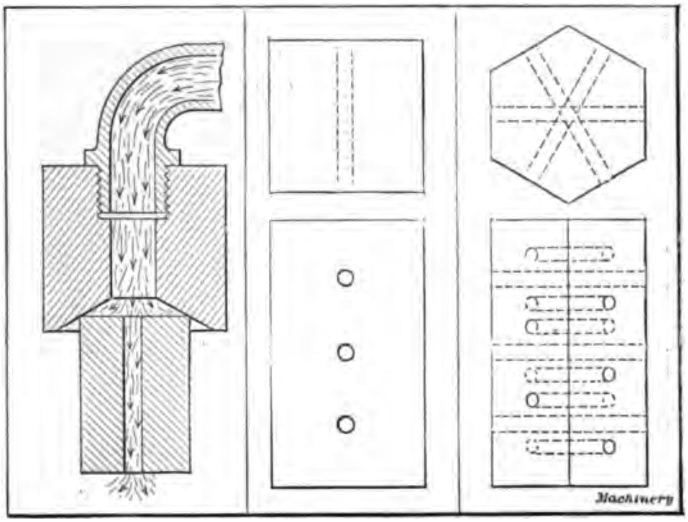


Fig. 44. A Method of hardening Solid Dies **Fig. 45. Multiple Die of Square Type** **Fig. 46. Multiple Die of Hexagonal Type**

of the die halves, as the cutting is done simultaneously with the movement of the dies. The operations of setting up the punches on the open-die machine are the same as on the solid-die machine.

Special Ball-heading Machinery

The E. J. Manville Machine Co. makes a special type of header adapted for forming ball blanks. The cold-header is an important adjunct to ball making. The principal feature is positive ejection for the ball blanks after heading, because ball headers operate at a very high rate of speed and positive ejection is absolutely necessary. A secondary advantage of this machine lies in its ability to handle positively the short ball blanks.

Fig. 47 shows a vertical longitudinal section taken through the working parts of one of these special ball headers. *A* is the frame or bed of the machine; *B* is the die-block of steel; *C* is a hardened tool

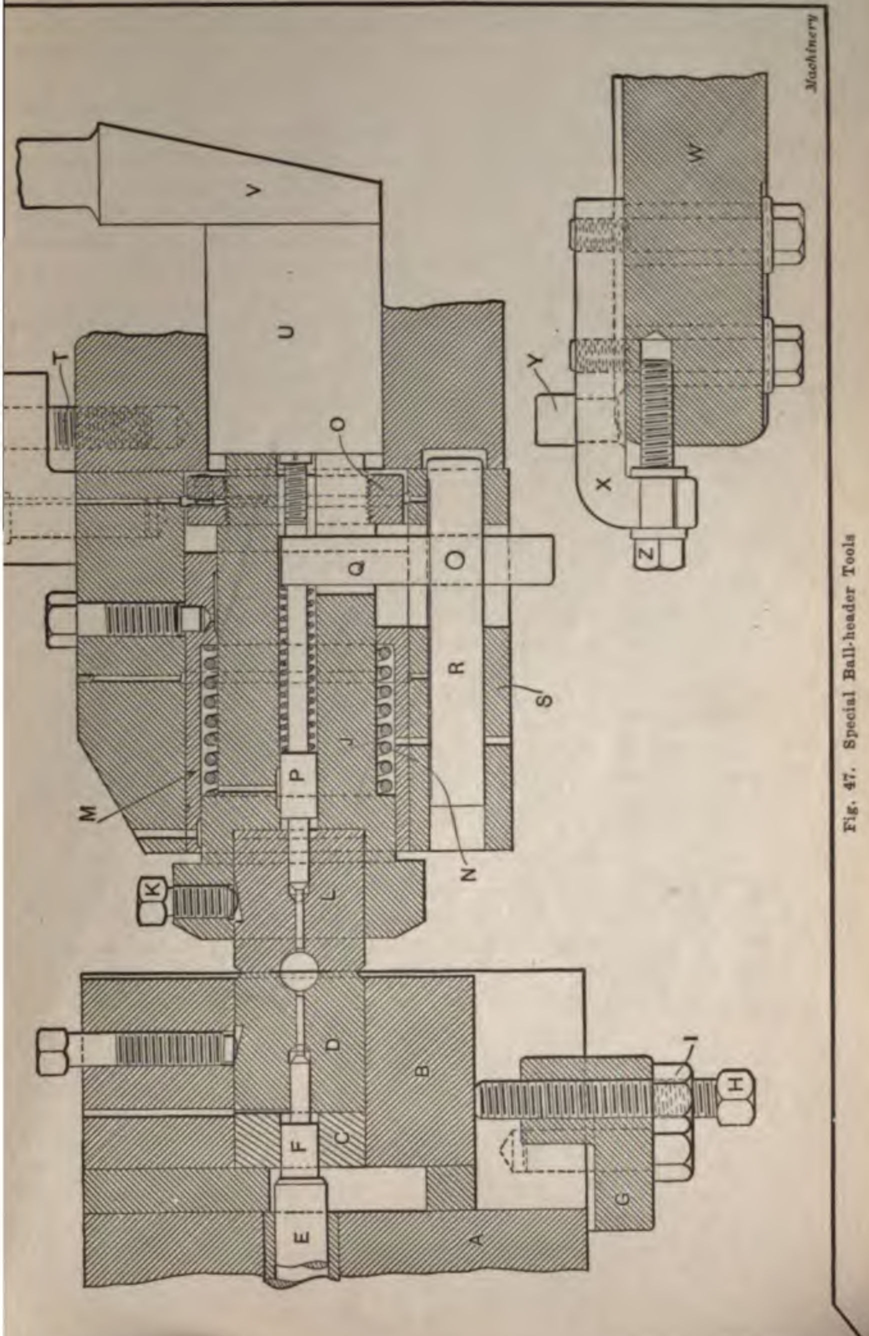


Fig. 47. Special Ball-header Tools

steel backing block for the die *D*; *E* is the backing or knock-out pin which backs up the smaller knock-out pin *F*; *G* is a cast-iron bracket screwed onto the under side of the bed to hold the adjusting screw *H* which raises or adjusts the die-block into the correct position for heading. A lock-nut *I* insures the adjustment. *J* is a tool-steel punch-holder having an enlarged head with a set-screw *K* for holding the punch *L*. The body of this holder is of smaller diameter than the head and is made a sliding fit in the bushing *M*. The holder is normally kept in its forward position under spring tension by means of the coil spring *N*. Two adjusting nuts *O* are on the back end of the holder. *P* is a small hardened tool-steel ejector pin, which is also kept under a spring tension, and is backed up by the bar *Q* that passes through the round rod *R* and is pinned in place. *S* is the punch-slide that carries the punch-holder and other parts shown and is adjusted by the screw *T*. The punch-holder is backed up by a solid block *U* that acts as a buffer as well as a filler between the holder and adjusting wedge *V*. *W* is a bar cast in the bed between the two sides carrying the adjustable bracket *X* that has the stop-pin *Y* and adjusting screw *Z*.

The action of the machine is as follows: The round bar or wire is fed in and cut off in the usual manner, and the cut-off blade carries a blank over to the heading die, but as there is no shank to be pushed into the die, as is the case with a longer blank or rivet, as soon as it is carried over, the gate or ram advances, and also the pin *F*. As pin *P* is under a spring tension the blank is very quickly seized between the two pins, and held in position until the gate has advanced far enough to hold and squeeze the blank into a ball.

After this the gate returns and when it has reached a certain position the bar or trigger *Q* strikes the pin *P* that acts as a knock-out, and ejects the ball if it clings to the punch; if it clings to the die the other ejector pin *F* ejects it.

It will be noticed that the pins *F* and *P* are not long enough to reach to the ball are when under the heading pressure; this leaves slight projections on the two sides which can be removed easily, whereas if the pins were even slightly too long there would be flat spots left on the finished balls.

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