

# THE BALL GAS ENGINES

DESIGNED TO OPERATE WITH

## NATURAL GAS

THE BALL ENGINES ARE ILLUSTRATED AND DESCRIBED HEREIN ACCURATELY, BUT WE RESERVE THE RIGHT TO MAKE SUCH CHANGES AND IMPROVEMENTS FROM TIME TO TIME AS WE DEEM ADVISABLE.

DESIGNED AND BUILT BY

### BUTLER ENGINE AND FOUNDRY COMPANY

BUTLER, PENNSYLVANIA, U. S. A.



THIS CATALOG is devoted to a brief description of The Ball Gas Engine. It is built in a factory well equipped with modern machine tools, operated by skilled mechanics, and an up to date foundry producing a superior grade of castings. This factory has been building The Ball Steam Engine for forty (40) years.

It is the oldest continuously built drilling engine in the oil industry. The Ball Steam Engine has had a deservedly good record in the oil country through all these years for efficient and long service. The Ball Gas Engine was designed and is being built to uphold this good reputation, which is the most valuable asset any manufacturer can possess. This firm builds nothing but engines giving all their time and energy to this single line of production, as much better results are obtained by this concentration of efforts than if their organization were occupied with a diversified product. Every member of this company is directly occupied in building The Ball Engine and all of them are determined that the generation old Ball Record shall be maintained.

The users of this kind of machinery are positively safe in doing business with this firm, and any one buying a Ball Engine will be satisfied with the investment. Our record for engine service in the past is the evidence we offer engine users of what may be expected from us in the future. The users of this kind of gas engines are respectfully asked to consider the following descriptive matter, and specifications of The Ball Gas Engine.

We consider inquiries from you as a favor, indeed, and all such will receive our careful attention.

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## PRINCIPLE

The Ball Gas Engine is of the two-cycle type, that is, an explosion occurs every revolution of the crank shaft, which feature makes this type of gas engine more regular in speed and much more powerful than the four-cycle type. Experience has proven the two-cycle best adapted for oil country requirements and similar work than any other type of gas engine. Since fewer parts are used in its construction and slower speed less attention and cost of upkeep is required than the four-cycle, and as it is so much more simplified in construction less experience and skill is required to operate it.

## GENERAL DESIGN

In the design and construction of The Ball Gas Engine the main thought was to secure simplicity, power, ruggedness, low cost of upkeep and operation. The accompanying illustrations and specifications with the engine's reputation in the oil country proves conclusively that the object of the manufacturers was realized.

The Ball will satisfy the demands of the most exacting users. There are as few parts in its construction as practical, and every one is easy to get at for inspection and adjustment.

There are only four (4) moving parts, piston, cross head, connecting rod and crank shaft, and only five (5) bearings subject to wear, two main bearings, crank, cross head pin and cross head slide bearings. All these bearings are ample in size to care for the wear and radiate the heat caused by frictional contact.

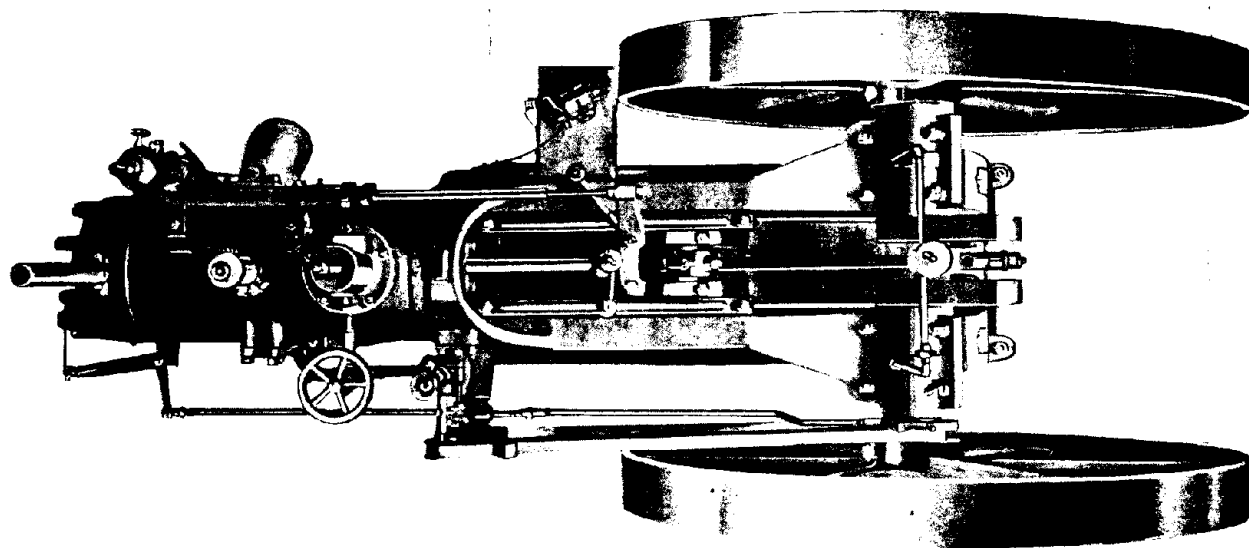
The construction provides a cross head moving to and fro on slide ways in central portion of frame, midway between cylinder and crank shaft. It acts as a tie between the cylinder as the generator of the energy and the crank shaft as the means of transforming the energy into work. Since this special cross head design takes the connecting rod out of the piston head it eliminates the excessive piston pressure and wear against the bottom of the cylinder found when the piston and connecting rod are directly connected.

The exhaust occurs at end of the stroke through ports cast in the cylinder. No exhaust valve exposed to the heat and pressure is required. There is but one valve used in the construction of the Ball Gas Engine and its purpose is to admit the air and gas into the cylinder in the proper proportion and is not exposed to the hot gases. There are no gears, cams, rods, levers, and

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Top View of 35 H.P. Ball, with Make and Break Electric Ignition.

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springs to keep in adjustment with their constant annoyance.

All screws, studs and bolts are United States standard, and with few exceptions studs are used instead of cap screws.

Every size of Ball Engine was scientifically tested out in every detail before the design was accepted to be built for the market. A record is kept of all engines, and all parts are built in exact duplicate by means of jigs, templates and gauges. (When ordering parts give engine number and part number as given in accompanying illustrated list.)

## PURPOSE

The Ball Gas Engine is built to meet the various requirements of the oil country and any similar work where simplicity, ruggedness, steady flow of power, and lots of it, are important factors. It is eminently suited for oil wells, refineries, machine and blacksmith shops, chop mills, stone crushers, cider presses, blowers, saw mills, gas and air compressors.

A great many of these engines are used to drive electric generators, and because of the more frequent impulse and simplicity of regulation are producing full and steady lights at low operating cost.

## DETAILS OF CONSTRUCTION

### BED, OR FRAME

The bed is double wall construction and extra heavy throughout. It is not only built for the purpose of carrying the weight of the working parts, but to hold together the cylinder as force generator, and the crank shaft and fly wheels through which the energy is transformed into work. It is well braced and reinforced on all of these lines of stresses.

The part behind the main bearings is in the form of an arch to withstand the crank shaft thrust. The main bearings are parted on a line of forty-five (45) degrees to the center line of cylinder and shaft in order to remove all strain on bolts and caps. The main bearings are lubricated by means of chains running over the crank shaft and lifting oil out of reservoirs in bottom of bed. The main bearing caps are firmly held in place by four (4) stud bolts suited to size of engine. The foundation flange is broad and heavy in which are the holes for holding down or foundation bolts. This bottom flange has a trough which carries off any oil drippings.

On all sizes from 15 H.P. up the bottom flange extends back under the cylinder as a sole plate which is used to sustain the dipping action of the cylinder at

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time of impulse. This support is adjustable and freely adapts itself to all expansion and contraction occurring in the cylinder.

Each size of Ball Gas Engines is provided with its own bed designed to sustain all stresses and wear according to the area of the particular cylinder. It is not the practice of this company to use one size of bed for several different sizes of engines.

### FLYWHEELS

Each engine is provided with two flywheels of ample diameter and weight which are carefully machined. All flywheels have unusually large hubs split on one side only. When the two (2) large hub bolts are heated and shrunk into place the hub is as strong as a solid one, but with a firmer grip on the shaft.

The wheels are held on the crank shaft ends by means of heavy steel keys of standard design. All wheels are carefully counterbalanced against the revolving crank pin and the reciprocating parts.

### CYLINDER

The cylinder is made from a close grained cast iron carrying a certain per centum of steel, and is accurately machined to size with plenty of stock for reboring. The

inner and outer walls are cast together with a wide space between them for the cooling water. This large water space, free from air pockets, is extended to and around all points subject to heat, insuring uniform temperature and avoiding unequal expansion and contraction. Ample provisions are made for removing the deposits precipitated by the cooling water. The inlet and exhaust ports are cast in the cylinder in such relation to each other that the entire use is made of the burning gases, and their complete discharge before the new mixture is admitted. The port arrangement in conjunction with the correct areas of the pump and explosion ends of the cylinder for speed and power have been carefully worked out with the indicator. The exhaust ports are water cooled in a way peculiar to The Ball, and are accessible from the outside to remove the carbon deposits, and inspection of piston and rings. The cylinder is attached to the bed by large stud bolts, which are easy of access.

### CYLINDER HEAD

The cylinder head is cast in one piece with wide water spaces and packing faces to conform to those of the cylinder.

The interior of the head forms the explosion chamber and since the greatest heat originates in it the water is admitted to cylinder through the head. It is held to its

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place on end of cylinder with large stud bolts, and is easy to remove to clean out water deposit in spaces, or if it is necessary to take out the piston head. In centre of outer wall is attached the tube and furnace bracket, or electric ignition head.

Since the ignition occurs in centre of the compression the flame flashes on radial lines to all parts of the mixture quicker and gives a higher initial pressure than is the case when ignition occurs at the side or top.

### **PISTON AND RINGS**

The piston head and rings are made from the same good quality of cast iron as the cylinder. The piston is carefully turned to fit the cylinder bore, and carries sufficient number of returned eccentric packing rings, which are securely pinned to the head with special pins so that the ring joints will not get in line.

The closed end, against which pressure is exerted, has a deflector or baffle plate, crescent shape, which causes the incoming mixture to flow in the proper direction. This baffle plate must cover the inlet ports, on the right hand side of cylinder, with the ends in a vertical position in order to get the proper results.

At any time compression is to be lowered or raised by screwing the piston rod into or out of the cross head  
**TURN THE PISTON ROD FULL TURN OR TURNS.**

which will always bring the baffle plate into its proper place over the inlet ports. **THIS IS IMPORTANT.**

The piston rings are roughed out larger than the finished diameter, cut open and sprung into a special jig with ends together where they are returned perfectly round and to the proper cylinder bore. Great care is used to have the piston and rings fit the cylinder bore just that close that expansion from heat will not set up any undue friction and cause these parts to cut, or wear too fast. This correct working fit utilizes the greatest possible amount of the explosion pressures. When engines are on the testing block particular attention is given to the action of piston and rings in cylinder, and every one is taken apart during the running test to determine the results before going to the warehouse.

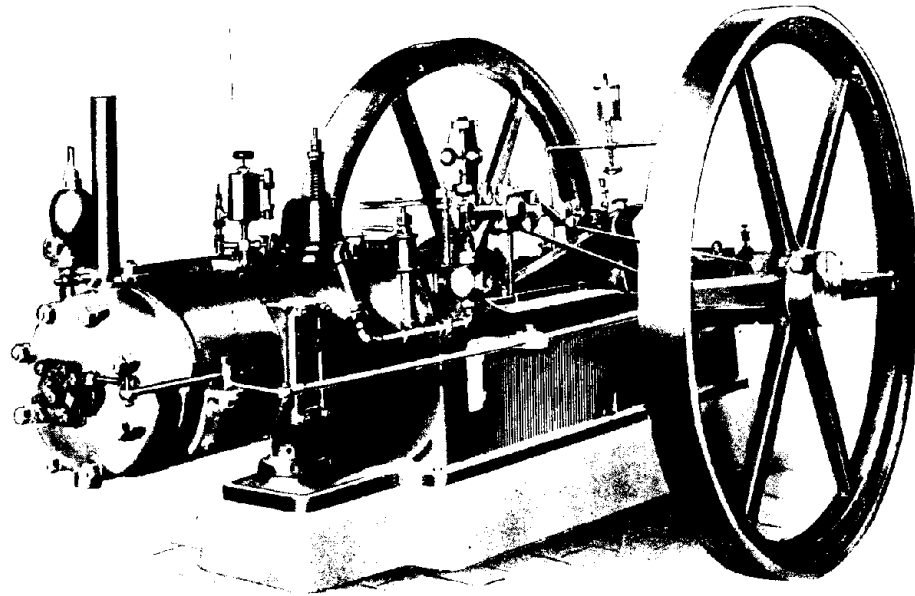
### **AIR AND GAS VALVE**

There is but one valve which is on the top side of the cylinder next to bed. It is not exposed to hot gases or pressures. It works automatically and its function is to admit and mix the air and gas. All valves are of large area and short travel. The travel of valve and spring tension are adjusted independent of each other. Since the valve disk is suspended on the stem instead of being supported, the stem travels through its slide guide freely and accurately, making a valve action that

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25 H.P. Ball, with Make and Break Electric Ignition.

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is uniform and true, in addition to reducing the wear to a minimum. As this valve works against very low pressure and no heat the seats are flat. The valve disk face can be leather lined which will work very satisfactorily.

The valve being on top side of cylinder its action is not interfered with by dirt and oil which collects in the bottom of the cylinder. This valve is very simple in construction, easy to get at and repair and its operation always in plain view.

### CROSS HEAD

The cross head moves on flat ways in the central part of the bed. The projecting planes, babbitted top, bottom and edges are of ample area to sustain all weights and pressures the head is to bear. A special steel pin is securely clamped and pinned into the cross head walls. It can be turned, or replaced with a new one at a trifling cost. This feature makes the cross head a part of the engine that will never wear out since the pin can be replaced and the babbitt rerun. The piston head rod is secured in end of cross head by means of coarse threads, large lock nut and set screw.

The connecting rod thrust against the cross head during compression half of stroke is taken up by heavy

and wide adjustable slide bars, which bear on the upper side of the babbitted cross head planes.

In addition to relieving the piston head of the connecting rod thrust and wear the cross head feature brings the connecting rod boxes out into plain view for inspection and adjustment and positive lubrication.

### CONNECTING ROD

The connecting rod is the strong marine type of rectangular cross section forged from selected steel billets. The heads are thick and provided with broad surfaces for attaching the bronze boxes, which is done by means of heavy bolts. In this type of rod the pressures are distributed over the broad surfaces of the heads, which is better than to be concentrated against wedge block or key adjustment.

### CROSS HEAD AND CRANK PIN BOXES

The cross head pin boxes are made from the very best bearing bronze, and ample in size for all pressures. The crank pin boxes are made either from the best bearing bronze, or a tough red brass lined with high grade pin babbitt metal.

Both boxes are split in halves and bolted to connecting rod heads with soft brass shims between the halves. These shims are to be filed down to get take up for

wear. This construction is good as the bolts can be drawn up solidly, making a rigid and firm connection with little danger of working loose.

The crank pin boxes are built so that either oil or grease can be used as lubricant, or if desired, both used at the same time.

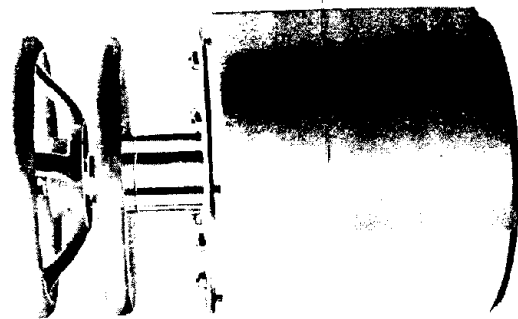
The cross head pin box is provided with oil lubrication only.

### CRANK SHAFT

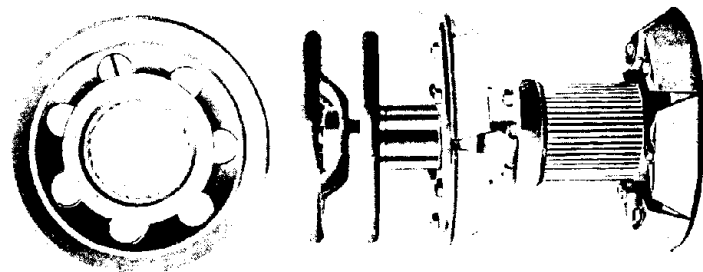
The crank shaft is made from open hearth steel forged in one piece from a solid billet of homogenous structure. It is of such carbon content that it insures good smooth wearing qualities, sufficient stiffness, yet elastic enough to bear the torsional stresses. The bearing sections are of large areas, the throws heavy and arm extensions sufficient to carry the wheels and transmit full power. Each shaft is carefully machined to gauges in our own shop, as are all parts of The Ball Engine.

### CLUTCHES

The Ball Hand Wheel One-Way-Clutch is either keyed on the shaft arm extending through the fly wheel hub, or it is flanged on hub of fly wheel as desired. This clutch is very simple in construction with little to wear out. Wood shoes, subjected to the wear, are



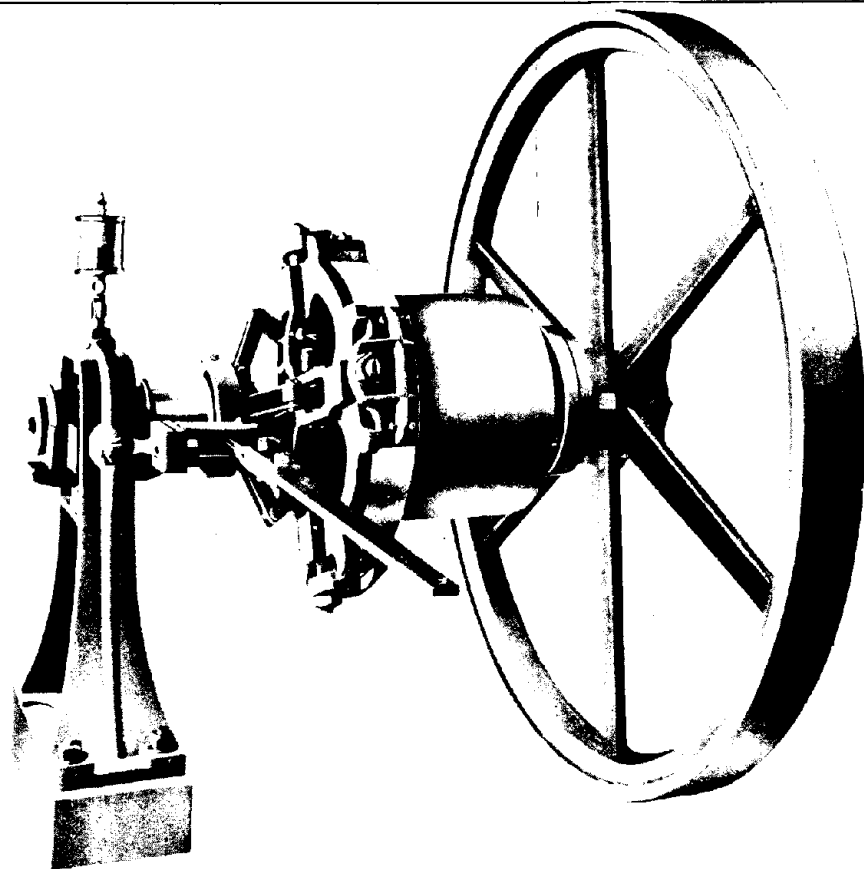
easy to replace and at little cost. There are two sets of wood shoes with large friction faces engaging similar faces on both edges of belt pulley rim at a 25 degree angle. This clutch will transmit full power without slipping, is easy to operate and when engaged is as rigid as a solid pulley. Clutch can be set up tighter for heavier load while running. Roller bearings are used between



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Ball One-Way Lever Clutch Operated at Stand.

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the pulley hub and hub that keys on the shaft, which feature makes engine easy to start as the friction set up by belt pull is relieved. Lubrication is provided for all working parts. A standard size pulley is furnished with each engine, but other diameters can be furnished to suit any kind of work to be done.

### ONE-WAY-CLUTCH WITH OUTER BEARING

If the work is heavy and belt strain excessive this lever clutch with outside bearing is recommended. It is built for the severest duties. The belt pulley is bronzed bushed and has an oil pocket for lubrication where it idles on the shaft.

The friction ring on pulley and wood lined shoes are large in area and will transmit full power without slipping on the load.

It is attached to engine shaft by means of shaft flanges or couplings being bolted together, one half on the clutch shaft, other either on flywheel hub or keyed on the engine shaft extending through the flywheel.

All working parts are provided with places for lubrication.

This clutch can be operated from the derrick floor, or at any convenient place in the engine room. It is built with two types of outer bearings, one with floor stand that extends to the floor line and the other with

a plain adjustable pillow block for which the foundation has to be built up within 8" of the shaft center.

### REVERSIBLE CLUTCH

There is no better solution of getting a reverse motion in connection with a gas engine than is found in THE BALL REVERSIBLE CLUTCH. It is the latest and best development of reverse gear for operating oil wells for which it was gotten out.

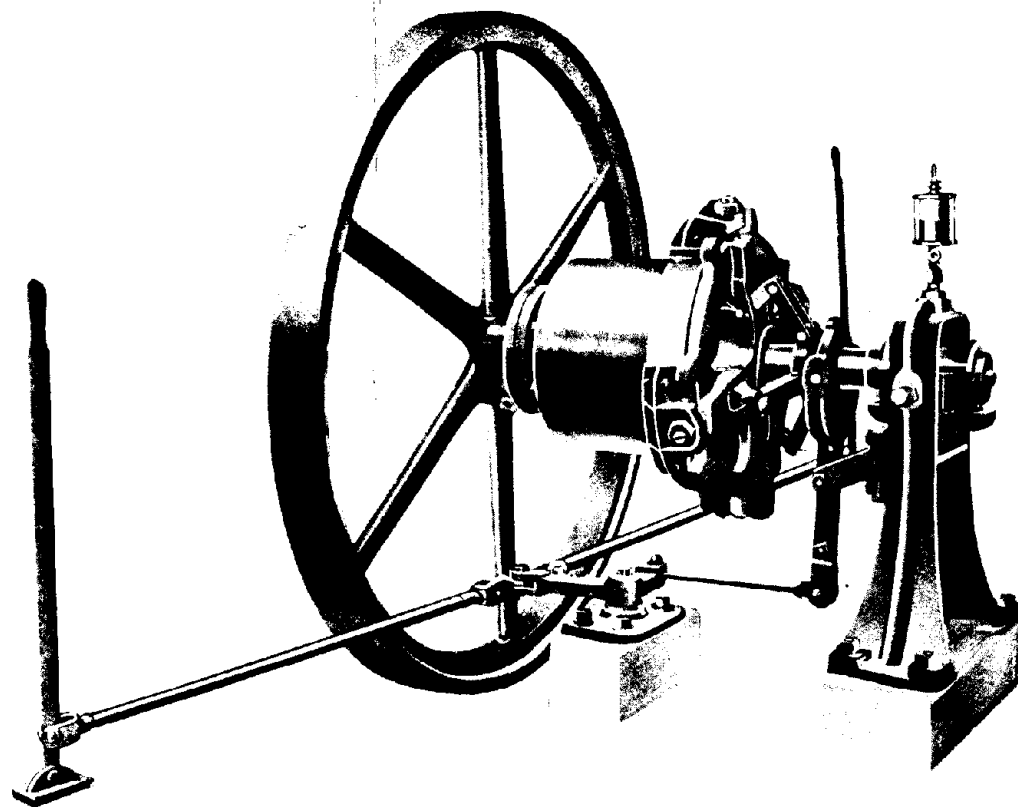
Spur gears are used, which are machined from solid steel.

All the steel gears work in a grease tight case which is packed with a special gear grease and heavy oil. All gears and revolving parts are bronzed bushed. There is more cast steel used in its construction than in any other similar device on the market. The method of lubrication is complete and will satisfy the most critical user.

It will not heat or cut when worked for long periods under heavy loads if the lubrication is attended to properly.

The friction ring on belt pulley and engaging shoes are of exceptionally large area, and will not slip when lifting the heaviest load encountered at deepest oil well. When on the reverse motion the forward clutch shoes clear the friction ring  $\frac{3}{4}$ ".

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Ball One-Way Lever Clutch, Operated Away from Stand.

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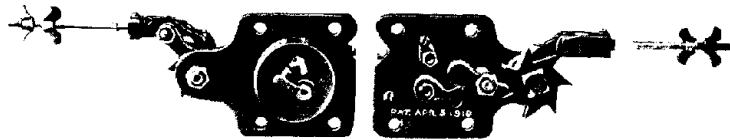
The fulcrum or lever plate is of such construction that the operation of clutch for either motion is accomplished with little effort. Levers to operate the clutch are placed in the engine house and on the derrick floor for the convenience of the attendant.

The outer bearing stand extends to its foundation just at the floor line, and is provided with four (+) heavy adjusting screws to move the bearing box vertically and horizontally.

Each clutch is given a thorough running test before it is taken to the ware house.

## IGNITION

The ignition is effected by means of either hot tube or electric spark. The hot tube method consists of either



a nickel alloyed tube attached to external end of cylinder, or an internal or blind tube attached to the inner cyl-

inder head wall or to the closed end of the piston. The external hot tube is heated by means of a special gas or gasoline furnace, while the internal tube depends on the heat of combustion for its glow. The blind tube will work satisfactorily if the engine is doing enough work to sustain a regular and high combustion temperature. When a blind tube is used the engine must be started with external tube and used until cylinder temperature is enough to keep it heated.

The electric ignition is either hammer make and break or jump spark. The make and break system has no exposed circuit breaker which is dangerous at gas compressors or wells with heavy flow of gas.

It is simple in design with substantial parts and very easy to repair. It is attached to center of cylinder head and operated by means of an eccentric on crank shaft. The timing of ignition can be made while the engine is running. The electricity is supplied by a high grade magneto and coil combined, which is either friction or belt driven, the speed of which is controlled by its own fly ball governor. This make and break system is furnished regularly when electric ignition is specified.

The jump spark is an efficient device in which the magneto, coil and timer are all combined in a single metallic case. This case is attached to the side of the bed under the governor and is operated from an eccentric on

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the crank shaft. A high grade plug is screwed into the center of the cylinder head and connected to the spark plug by a single short wire.

Time of spark occurrence can be changed while engine is running same as in the make and break. An external hot tube outfit is furnished with each system of electric ignition as part of the equipment. All of these methods of igniting the mixture have been thoroughly worked out in every detail and any of them will give excellent results.

## GOVERNING

The Ball Gas Engine is governed by the variable impulse method, which gives constant compression. It is unquestionably the best method for the oil country where a continuous flow of power and a steady speed is desired, without the "jerky" effect of the hit and miss type of governing. It is accomplished by means of a special sensitive fly ball governor of few joints acting directly on the gas supply. This equipment in conjunction with the Ball By-Pass Valve affords a dependable derrick control equal to the steam engine. When the Ball Reversible Clutch is part of the installation for the load control the operator has the very best outfit on the market for pumping, pulling rods and tubing, cleaning out and drilling.

## GASOLINE ATTACHMENT

When oil wells are isolated from gas supply and casing head gas is insufficient any Ball Gas Engine can be equipped with a gasoline generator valve in a few minutes that will run the engine with part gas or all gasoline. This special valve is screwed into the threaded air inlet part of the air and gas valve and supplied with gasoline from a reservoir by gravity. If the engine is equipped with an external hot tube and not enough gas to heat the tube raise the furnace to admit flame from painter's torch to heat the tube. If cylinder heat is sufficient after engine has been started, painter's torch can be removed and ignition secured by means of blind tube. If engine pounds on gasoline, lower the compression by screwing the piston rod into the cross head two or more FULL TURNS. These gasoline outfits are kept in stock for hurry-up calls from the oil fields.

## LUBRICATION

The lubrication of gas engines is a matter of the utmost importance, especially the cylinder, which has been worked out in Ball cylinders with excellent results. Every piston ring passes over the oil hole in cylinder and the last ring on piston end, which is subjected to the greatest heat and friction, stops at end of stroke directly

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under this oil hole. It is apparent that every ring on the piston actually is oiled by this construction, and does not depend on oil being worked back to them. The rings are pinned on head at such place that there is a proper and equal distribution of the oil over the entire surface swept by the piston head. Moreover, the oil when first entering the cylinder in forms of drops is not blown away by the rushing gases incoming and outgoing, as found in many instances, but is picked up by the piston and rings and then worked into a thin film on the walls before being exposed to the moving gases.

This effective cylinder lubrication is due primarily to the correct arrangement of the inlet and exhaust ports. On specification the cylinder can be equipped with a special pressure sight feed oil cup of large capacity which is worked from the front, or pump end pressure on forward travel of piston. Cylinder can be lubricated by means of mechanical force feed operated from the crank shaft. The regular equipment is a sight feed release tube type of lubricator of large capacity.

THE MAIN BEARINGS are constantly flooded with oil when the engine is running. Special chains around the crank shaft lift the oil out of reservoirs in base flooding the entire frictional surface. Oil channels returns the oil into reservoirs.

THE CRANK PIN BOX is provided with a large gravity sight feed oil cup supported by a heavy oil rack built into engine. The outer part of the crank pin box is arranged for a self feeding grease cup. These two lubricants, oil and grease, can be used at the same time when so desired.

THE CROSS HEAD PIN and BABBITTED PLANES are lubricated from gravity sight feed oil cups carried by rigid oil racks built into the engine. The outer clutch bearings are lubricated in the same manner.

## GAS CYLINDER OUTFITS

If a low price gas engine is desired THE BALL GAS CYLINDER OUTFIT attached to oil country steam engine beds makes an ideal engine of this converted type. It is built in 10, 12, 15 and 18 H.P. sizes with selection of 14", 16" and 18" diameter clutches.

The outfit is shown in plate No. 3 of illustrated parts according to numbers 273 to 280, inclusive.

The Ball Cylinder can be attached to steam beds at well by the lease men, or in any repair shop. The 15 H.P. size should never be used on any bed lighter than a 20 H.P. and the 18 H.P. on lighter steam beds than 28 and 30 H.P. If possible two fly wheels should be used, and if only one, bolt on all the sections in order to ob-

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tain all possible wheel momentum, which will give a steadier and smoother motion. Most cylinder outfits used in the oil country are underwheeled, which is the principal reason for so many broken beds and rapid wearing bearings.

If the steam bed is not in use on block at the well it is advisable to send it to this factory to be repaired, and cylinder attached. This method makes the engine a better investment for the trade. The bed, shaft, wheels and all parts can be put in good working condition for the new cylinder, and when assembled tested out for a complete job.

## TESTING

Testing the Ball Engines begins first with all raw material delivered to the factory, and then each separate piece is repeatedly examined as it goes through the factory to detect faults before it becomes part of the completed engine. When engine leaves the erecting floor it goes to the testing room for final test and approval. All engines are put through a severe running test to reveal any faults missed while building, and each engine must work out in satisfactory manner before leaving the testing block.

All bearings are adjusted to a full and equal contact. The piston, rings and cylinder bore are carefully inspected during the running test. The bearings are adjusted so that they run without knock. Engine must develop full power under brake and one man be able to start it by hand. The makers are sure by this course that each engine is right when it leaves the factory.

## FINISH AND APPEARANCE

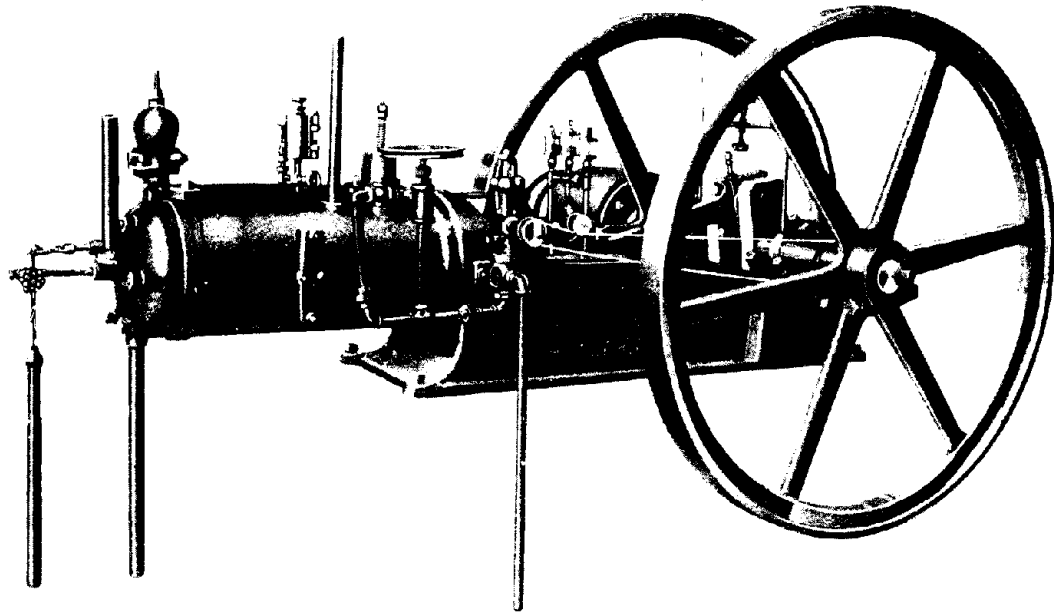
The frame, cylinder and wheels of Ball Engines are painted with a dark green enamel machinery paint. The forgings, edges and faces of fly wheels are trimmed in black enamel machinery paint.

This not only makes a durable but a pleasing finish.

All bearings and machined parts are covered with a special slushing oil to prevent rusting. The general appearance of The Ball Engine is suggestive of power and ruggedness, yet the lines are graceful and pleasing. Since The Ball is built for utility and service no needless expense has been added to its construction cost by polishing and burnishing parts other than frictional bearings.

No nuts, plates or covers are polished; they are covered with a durable and elastic enamel paint just to protect them from rust. The builders of The Ball learned long ago that the users of this type of engine preferred

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12 H.P. Ball, with External Hot Tube Ignition.

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the cost of polishing and burnishing to be turned into more power, strength and better material.

## HORSE POWER RATING

All Ball Engine power ratings are considerably below the actual or brake horse power.

Every engine must develop a certain per centum above the listed rating before it is taken off the testing block.

This margin is given for the inevitable wear, and for peculiar hard working conditions often encountered.

Any increased speed over the listed speed in Table of Specifications will produce more horse power. THE BALL GAS ENGINE possesses a great reserve of power as the occasion demands, which fact makes it a prime motive power for such work as found around oil wells, factories and mills.

## INSTALLING

If desired, blue prints will be furnished giving measurements and instructions for setting any type of Ball Gas Engine.

FOUNDATION must be free of all bumps, and engine must set level both ways, otherwise bed will bolt down in a strain, and lubrication will be unequal.

FLY WHEELS must be placed on shaft according to numbers stamped on hubs and shaft ends, and word "out" cast on spokes facing away from engine. First expand hub, slide wheel over shaft to place, line up keyways and knock out expanding wedge.

Next heat shank of hub bolts to color, tighten nuts down snugly and when **bolts are cold drive key**. When moving engine to new foundation never roll the shaft out of bed with wheels attached, always remove the wheels from shaft.

When HAND WHEEL CLUTCHES are keyed on engine shaft slide clutch over shaft then remove all the front parts to drive up the key, leaving clearance between stem nut and key. If this clutch is flanged on the manner of attaching is simple and easily seen.

Never tighten nuts on stem end down on thrust ball bearing but leave clearance between them to secure free action of the hand wheels. If these nuts are tightened down on the ball bearings the hand wheels will not work free, and clutch will be difficult to throw in and out.

All OUTER BEARING CLUTCHES are flanged on the flywheel hub, and the method is very simple and

apparent. Be careful to get this outer bearing and engine main bearing in exact alignment.

After the stand is bolted to its foundation in a plumbed position, and bearing boxes inserted make preliminary adjustment with large screws. When the belt is on and engine running make the final adjustment, feeling engine and stand bearings for first heat, using either the verticle or longitudinal screws to get the two sets of bearings to carry their portion of the stresses.

WET GASOMETERS should be placed outside the engine room in weather proof enclosures. In winter fill the can with oil, and in summer water can be used.

DRY GASOMETERS can be placed in engine room, providing overflow pipe is attached and extended outside the building.

GAS PRESSURE of  $\frac{1}{2}$  to 1 pound is enough to heat the tube and supply cylinder, providing the volume of flow is sufficient. If not, the supply is inadequate, or lines too long for the diameter of pipe used.

The COOLING WATER SYSTEM is very important and must be given intelligent consideration to get the greatest engine efficiency and wear. When water is circulated, use large diameter overflow pipes, which must enter tank 18" below top of tank stave and extend into tank 18" with elbow and nipple on end to be able to raise and lower point of outlet to suit the water level, and to

raise in verticle position to drain. Water level must be kept above this overflow outlet in the tank. Never put overflow pipe over the top of tank stave, except when using water pump or gas jet to circulate the water. This method makes a boiler of the gas cylinder, when change of temperature is used to circulate the water, for enough steam has to be generated to lift the water above its level to get it back into the tank. (See subject of Cooling Gas Cylinders under Operation and Care). In instances where the engine works near rating long periods of time, and water is too scarce to waste on ground attach pump to lugs on cylinder, or jet a little gas into overflow pipe through tee just above cylinder to accelerate movement of water.

All GAS PIPE FITTINGS should be new, otherwise deposit in old pipe and fittings will find its way into governor, valve, burner and cylinder causing annoyance and possible cylinder cutting.

If desired a pipe can be carried from the air and gas valve outside the building. If a gasometer is used the pipe for tube furnace must connect with gas line before gasometer.

OIL WIPERS must be securely set to their place, using care to get the blades to brush the wicks hard enough to wipe off the drops of oil. In shipping and setting gas engines dirt and grit get into the bearings which should be removed before starting.

The crank pin boxes should be taken off and thoroughly cleaned. Do not remove the plugs and boards on cylinder until ready to attach the parts. Before starting engine look it over carefully to determine if all the parts assembled are securely fastened in place.

## STARTING

Fill all cups and reservoirs with a good grade of gas engine oil. Heat the tube to a bright cherry red. With crank in a vertical position turn on gas until it blazes up 8" to 10" at valve when lighted, which is usually enough gas to start.

After expelling all gas through release valve at end of cylinder stop with crank pin at outer centre. Now set gas dial to predetermined mark and when starting by hand turn wheels backward about one quarter revolution which will draw the mixed air and gas into the front end of cylinder, then turn the wheels forward until crank stops at outer centre again which will allow the mixture to flow into the explosion chamber.

It usually requires two of these operations to charge the cylinder, and on the third reverse turn of the wheels bring them back more than a quarter turn and with considerable vigor, which will raise the compression enough to ignite the charge in explosion chamber. When the

impulse occurs turn on a trifle more gas at the dial. If charge is too rich the explosion will occur with a dull thud, and if not enough gas in the mixture more than three backward turns of the crank will be required to get an explosion.

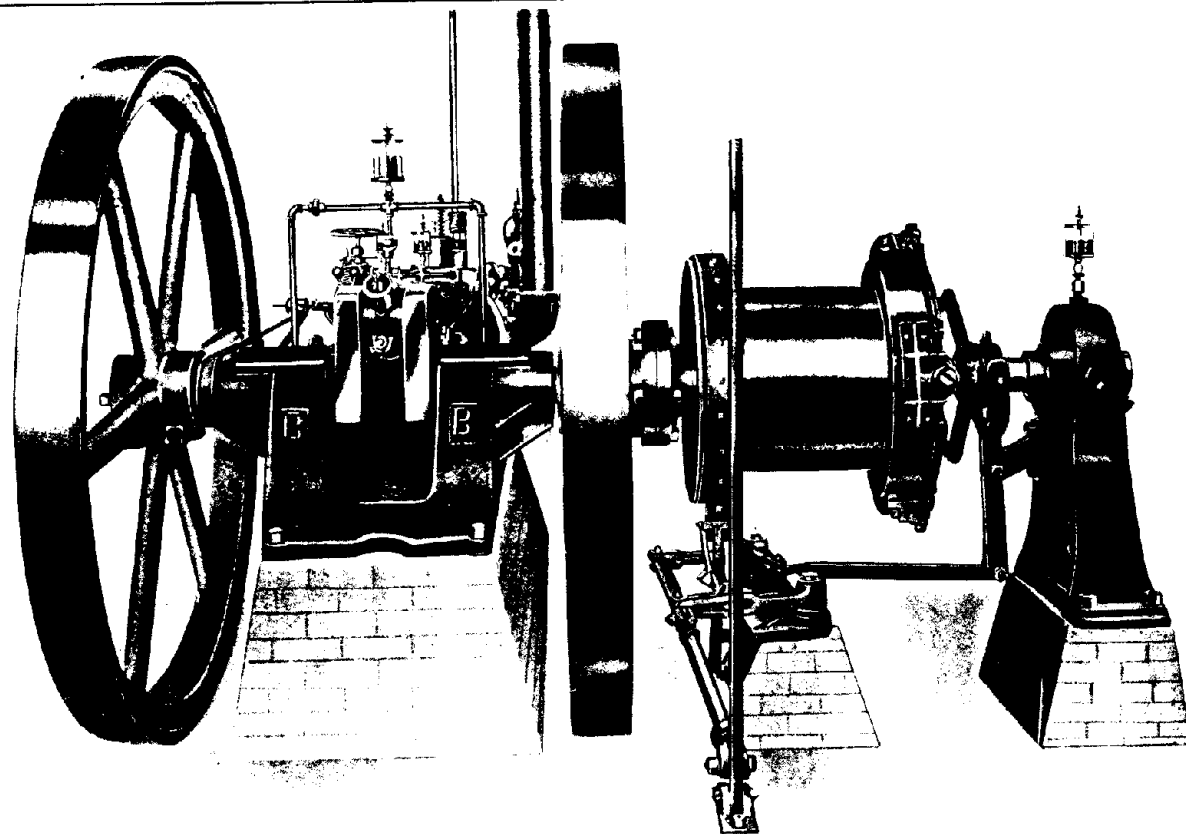
When making new trial to start engine, always shut off the gas at dial, and turn the flywheels around one or two turns to expel all burned gases through the release valve. If high gas pressure at dial, "wet" gas or gas of poor quality makes starting difficult, use a little tank oil or gasoline through release valve at end of cylinder, or the air and gas valve on top of cylinder. This is usually done with gas shut off until first explosion occurs when it is turned on again. Before turning on lubricating oil flush the frictional bearings with lamp or tank oil to float off the dirt and grit. Turn water into cylinder in sufficient amount that the hand can be held on the cylinder without discomfort, which will be about 125 degrees F. Allow the engine to run long enough without load to determine if bearings run cool. Do not snap clutch in with a jerk, but make the shoes come into their place with a steady and firm motion.

## REGULATION

THE CONTROL of Ball Gas Engines is accomplished by means of air and gas valve, fly ball governor by-pass valve and timers on electric sparkers.

BUTLER ENGINE & FOUNDRY CO.

BUTLER, PA., U. S. A.



Wheel End of 20 H.-P. Ball, with Reversible Clutch.  
*The Ball*

If speed and load are fairly uniform give governor full range, then set the gas dial to get the proper speed. after which the governor regulation is screwed up enough that after any allowed increase of speed occurs the governor will hold the engine to that motion. If the load is variable screw governor speed regulating thumb screw up to secure the desired speed, and then turn on enough more gas at dial as is needed for the maximum load thrown on the engine. In no instances run with the gas dial wide open or even more than needed for the maximum load. When PULLING RODS, TUBING or TOOLS set governor at highest speed desired, and just enough gas through dial to keep engine running at fair speed. When more speed or power is desired give engine extra gas through the by-pass valve, which is connected with cord wheel on the headache-post in derrick floor. The air and gas valve is provided with adjustment for valve travel and spring tension that are independent of each other. The spring tension should be strong enough at any speed to close the valve securely against its seat. If valve spring is too tight it will flutter and not give sufficient charge for heavy work or high speed. Then if there is too little tension on spring the valve will hammer on high speed. SHORT VALVE TRAVEL is proper for light loads at any speed or for poor quality of gas.

LONG VALVE TRAVEL is better for heavy loads at any speed and for a rich gas.

If electric ignition is used it is essential that the place spark occurs in piston travel should harmonize with the above various speeds.

In a continuous slow speed the spark should occur a trifle before the piston comes to the end of its travel, and in continuous high speeds earlier in proportion to the speed. In every instance, retard spark just enough that engine will not pound on too early ignition.

When there is no regular speed or load, as in case of pulling, cleaning out and drilling oil wells, compromise the place ignition will occur by setting the timer so that at the slowest speed encountered there will not be much or any pounding.

## OPERATION AND CARE

During a reasonable time after starting clutch, all bearings, keys, studs, set screws, nuts, cooling water and oiling system should be watched more closely than usual in order that one in charge becomes familiar with engine and its operation, and that all parts are properly adjusted.

Outside clutch bearing and the engine main bearings must be kept in true line. The holding down bolts and engine block keys should be kept tight so engine will not jump when run fast.

*The Ball*



CRANK SHAFT RUMBLING is eliminated by tightening down the main bearing cap on the governor side. VALVE FLUTTERING is sometimes caused by pasty substance accumulating on stem and seat.

TUBE FURNACE COMBUSTION is sometimes insufficient from flakes from asbestos liner piling up at bottom, and clogging the air holes, or by small particles in gas hole of burner. Never have tube any hotter than will give good ignition. UNUSUAL NOISES or loose and pounding joints should be attended to at once. Do not put off until tomorrow for serious damage may be done the engine and years of wear taken out of it in a few short hours of neglect.

COOLING THE GAS CYLINDER is a matter of vital importance as the temperature of the burning gases is as high as 1800 degrees F.

Water is circulated around the outside of the cylinder wall to carry off  $\frac{1}{3}$  to  $\frac{1}{2}$  of this intense heat, otherwise the oil would be destroyed and the moving piston and rings soon cut and lock against the cylinder walls. Water should leave the cylinder not more than 75 degrees F. higher than the temperature it enters.

If the hand can be held on the cylinder or overflow pipe a brief time the best results are obtained. The water should never get any hotter than 175 degrees F.

BAD OR MUDDY WATER is better circulated than wasted on the ground but keep the water level in tank just over the overflow pipe outlet.

SALT WATER can be used with good results but all joints must be kept tight as the least ooze will eat away the iron.

SEDIMENT OR DEPOSITS of any kind must not be allowed to fill up the water space since this will interfere with the proper lowering of the high temperatures and cause rapid cylinder wear.

It is good practice to remove the deposits at regular and proper periods which is governed entirely by the nature of water used.

LUBRICATION of gas engines must be given intelligent care and regular attention, especially the cylinder. Use nothing but the best grade of mineral gas engine oil in the cylinder and in sufficient quantity, which depends on size of cylinder and amount of work being done. If the cups are adjusted for light work increase the flow when more work is to be done. Enough oil may be used but in such irregular applications that periods occur with little or no oil, causing excessive and needless wear, if not serious damage. Oil in the reservoirs under the main bearings must be replaced when it gets thick and slate

color. The heavier and worn oil can be drawn off at the bottom and fresh oil used to replace it.

CHANNELS at each edge of the main bearings carrying oil back into reservoirs must be kept open or the oil will flow over and down the sides of bed.

OIL CUPS should be taken apart and cleaned when sediment appears on the bottom.

ALL CLUTCH BEARINGS are provided with means for lubrication. When clutch idles on rollers or bronze bushings oil such bearings through the face of the pulley at plugs marked "OIL."

GEAR CASES, in reversible clutches, are filled with high grade cup or gear grease and heavy steam oil at the factory. When gears work with a dead muffled sound there is sufficient grease, but if the gears are noisy with sharp metallic sounds, more lubricant is needed in the gear case. There may be enough grease in the case which has become hard after a time and will not flow over the gears and bronze bushings. Then, by means of brass force gun, furnished with each clutch, inject heavy steam oil, or tank oil boiled until thick, into gear case through plugged hole marked "GREASE & OIL," which is found next to the fly wheel. When the reverse motion is used daily as in pulling, cleaning out and drilling oil wells, start each 12-hour period with a little heavy oil forced into gear case, which will keep the lubri-

cating mass thin enough to flow over all parts requiring lubrication. If the case lubricant becomes so thin that it leaks out, inject cup grease into the case to thicken the lubricating mass.

At same side of clutch squirt engine oil into pinion gear shafts through  $\frac{1}{8}$ " pipe plugged holes. All these places are marked "OIL" or "GREASE" in large letters cast into the parts.

CLUTCH LUBRICATION is so well provided for if not neglected there will be no danger of bearings and gears cutting and sticking.

CRANK PIN can be lubricated with either oil or cup grease or both at the same time.

PISTON SQUEALING or groaning indicates either insufficient or poor grade of oil, or that rings are cemented in their grooves and bear unequally and too hard against the cylinder wall. If the rings are carboned take piston out of cylinder and remove the deposit of carbon. This removal of carbon must not be neglected if full power and long wear of cylinder is an object. How often it is done depends on temperature of cylinder, work and quality of oil.

To remove the carbon from piston and rings work the rings in their grooves by pushing on ends with stick at same time pouring kerosene into the grooves to dissolve the carbon and float it off.

This should be persisted in until the rings are free, and the oil comes off clear. If there is much carbon under the rings remove them in order to get it out. To do so insert thin strips of sheet iron under the ends and along the sides which will spring the rings out of their grooves. The carbon accumulating under the rings prevents their free action, and often pushes them out hard and unequally against the cylinder wall which causes it to wear out of round. If the rings are burned in too hard to loosen break them out and replace with new ones. Remove carbon out of the ports, and carefully wash all grit off piston and out of cylinder with light volatile oil before replacing it.

LOCATING PISTONS properly in all sizes of Ball Gas Engines is to let the end of it protrude through the cylinder no less than  $\frac{1}{2}$ " nor more than  $\frac{5}{8}$ " which will allow the last ring on the head to travel over the cylinder end. The BAFFLE or DEFLECTOR PLATE, crescent shape, must cover the inlet ports on the right hand side of the cylinder with ends of the deflector plate in a vertical position. This is IMPORTANT. Gases being so unlike in their value it is often advisable to change the compression in order to get the best results out of the engine with the particular gas used.

The compression is the pressure that mixture of air and gas is raised to at time of ignition by the piston

moving into the explosion end of the cylinder. If the gas is poor raise the compression by unscrewing the piston rod out of the cross head, and if the gas is rich lower it by screwing the piston rod into the cross head. In either instance turn the rod complete turns so as to bring the deflector plate over the inlet ports properly.

The compression is set in the factory for the average gas found in the natural gas regions. Weakening compression through cylinder wear can be raised as needed by unscrewing the piston rod out of the cross head, always **full turn or turns**.

PREMATURE EXPLOSIONS or back firing occurring when the ports are open, is caused by the mixture still burning when the inlet ports are opened to admit a fresh charge. This trouble may be due to tube being too cold, compression too low, piston rings carboned fast, too much oil, cylinder too hot or small point of carbon or iron on piston end or explosion chamber being in a glow.

TO TEAR DOWN REVERSIBLE CLUTCH for inspection and repair proceed as follows: Remove outer bearing stand leaving the clutch flanged to the flywheel; then loosen up and remove the set screws in hub of driver or spider after which tap and pull the driver off its key in the shaft. Next use socket wrench to remove three hexagon tap bolts in brake wheel on flywheel

side, and then at same place tap short iron bar against the six pinion gear shaft ends, showing through the brake wheel wall, which will loosen the shafts in their taper seats. When the shafts are loose, give the belt pulley a vigorous jerk and it can be pulled off over the shaft end, exposing the internal parts of clutch.

If it is necessary to remove the rim gear, keyed on the belt pulley hub, screw a stud bolt into taped hole in key head using the stud as a jack to pull the key, which will release the rim gear, space collar and gear case

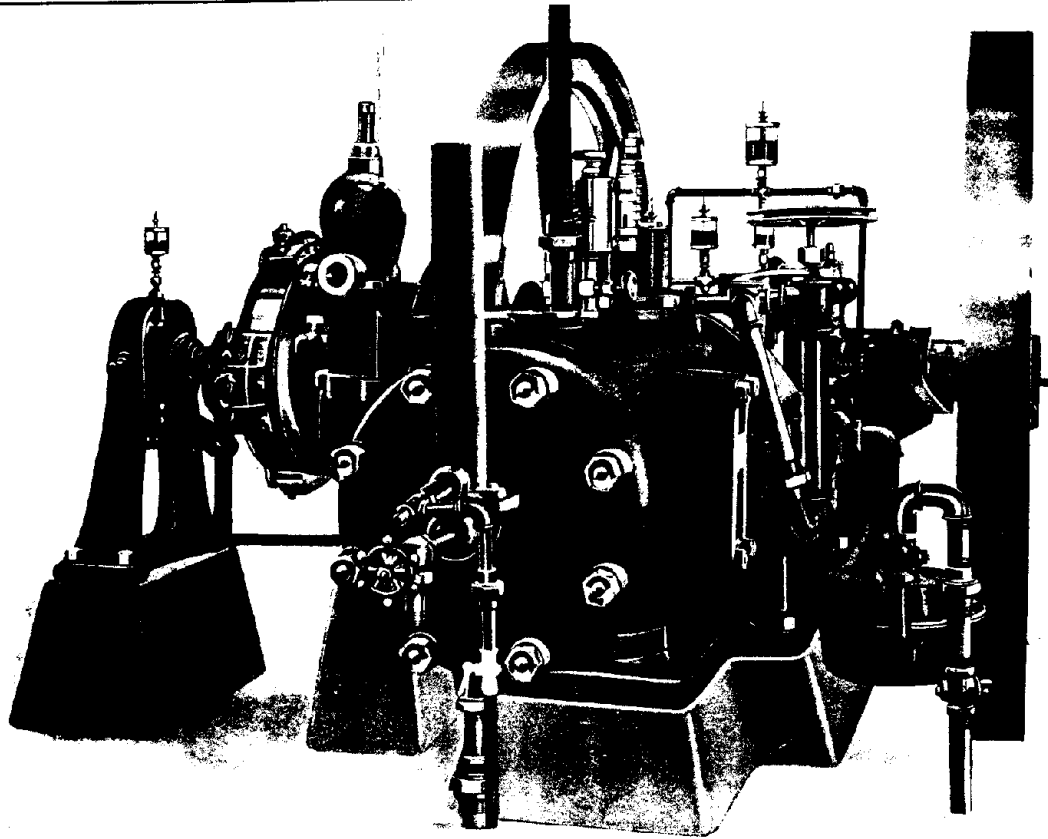
shell. To remove the reverse gear from shaft tap on an iron bar against the brake wheel hub which will drive both reverse gear and brake wheel off together.

To assemble the clutch reverse the operation. It is not a difficult matter to take apart or put together a BALL REVERSIBLE CLUTCH if a little thought and care is exercised in connection with these directions. Always refill the gear case with cup grease and heavy cylinder oil.

*The Ball*

BUTLER ENGINE & FOUNDRY CO.

BUTLER, PA., U. S. A.



Cylinder End 30 H.P. Ball, with External Hot Tube Ignition.

*The Ball*

## BALL GAS ENGINE SPECIFICATIONS

Horse Power	12	13	14	15	20	25	30	35
Revolutions	210	210	210	185	175	170	165	160
Cylinder Bore, inches	7½	8	9	9	9¾	11	11¾	13
Stroke, inches	12	12	12	14	15	16	17	18
Length of Piston, inches	13½	13½	13½	15½	16½	17½	18½	19½
Main Bearings, inches	4x8	4x8	4x8½	4¼x9	4¼x9½	4½x10½	5x11	5x12
Crank Pin, inches	4x4	4x4	4¼x4	4½x4¼	4½x4¼	5x4½	5½x4½	5½x4½
Cross Head Pin, inches	2¾x3	2¾x3	3x3	3¼x3¼	3¼x3¼	3½x3½	3¾x4	4x4
Cylinder Water Spaces, inches	1	1	1¼	1¾	1½	1½	1¾	1¾
Dia. Exhaust Pipe, inches	3¼	3¼	4¼	4¼	4½	4½	4¾	4¾
Flywheel Diameter, inches	58	58	60	62½	66½	68½	73	73
Flywheel Hub Bore, inches	3½	3½	3½	4	4	4	4½	4½
Flywheel Face, inches	4	4	4¼	4¼	5¼	6	6½	7
Flywheel Weight, pounds	600	650	700	800	1,050	1,375	1,625	1,800
Floor Space	60x120	62x120	68x130	72x138	74x142	79x150	86x160	88x162
Engine Weight—No Clutch	3,200	3,500	4,250	4,950	5,800	6,800	9,000	10,000

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SPECIFICATIONS ONE-WAY HAND WHEEL CLUTCHES  
ROLLER BEARING

Diameters, inches		14	16	18	20	22	24			
Face, inches		13	13	13	13	13	13			

SPECIFICATIONS OF ONE-WAY LEVER CLUTCHES  
BRONZE BUSHED BEARING

Diameters, inches		18	20	22	24	26	28			
Face, inches		13	13	13	13	13	13			

SPECIFICATIONS OF REVERSIBLE CLUTCHES  
BRONZE BUSHED BEARING

Diameters, inches		18½	20	22	24					
Face, inches		14	14	14	14					

SPECIFICATIONS OF GAS CYLINDER OUTFITS FOR STEAM BED FRAMES  
ILLUSTRATED NOS. 273 TO 289.

Horse Power		10	12	14	15	18				
Bore		7½	8	9	9	10				
Stroke		12	12	12	14	12				

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## ORDERING REPAIR PARTS

In order to avoid delay and confusion in ordering engine and clutch parts please follow these suggestions:

For engine part, give the number of engine, for record reference, with the name and number of the illustrated part desired.

Example: Engine No. 1450 cross head pin part No. 28 in plate No. 1.

Reversible and one-way lever clutches give engine number, name and part number with dia. belt pulley, dia. and face of friction ring. Example: Engine No. 1604 reverse (or one-way lever) clutch driver part No. 202 in plate No. 2 for belt pulley 20" dia. with friction ring 24" dia. x 3½" face.

One-Way Hand Wheel Clutches give the engine number, name and number of illustrated part with dia. of belt pulley.

Example: Engine No. 1203 wood shoe block part No. 258 in plate No. 3 for 14" dia. belt pulley.

Always state if goods are to be shipped by express, freight or parcels post.

Butler, Pa., home of The Ball Engines, has the advantages of the three main express companies, four main steam roads, two electric roads and parcels post to make quick and direct shipments of goods to any place in the United States.

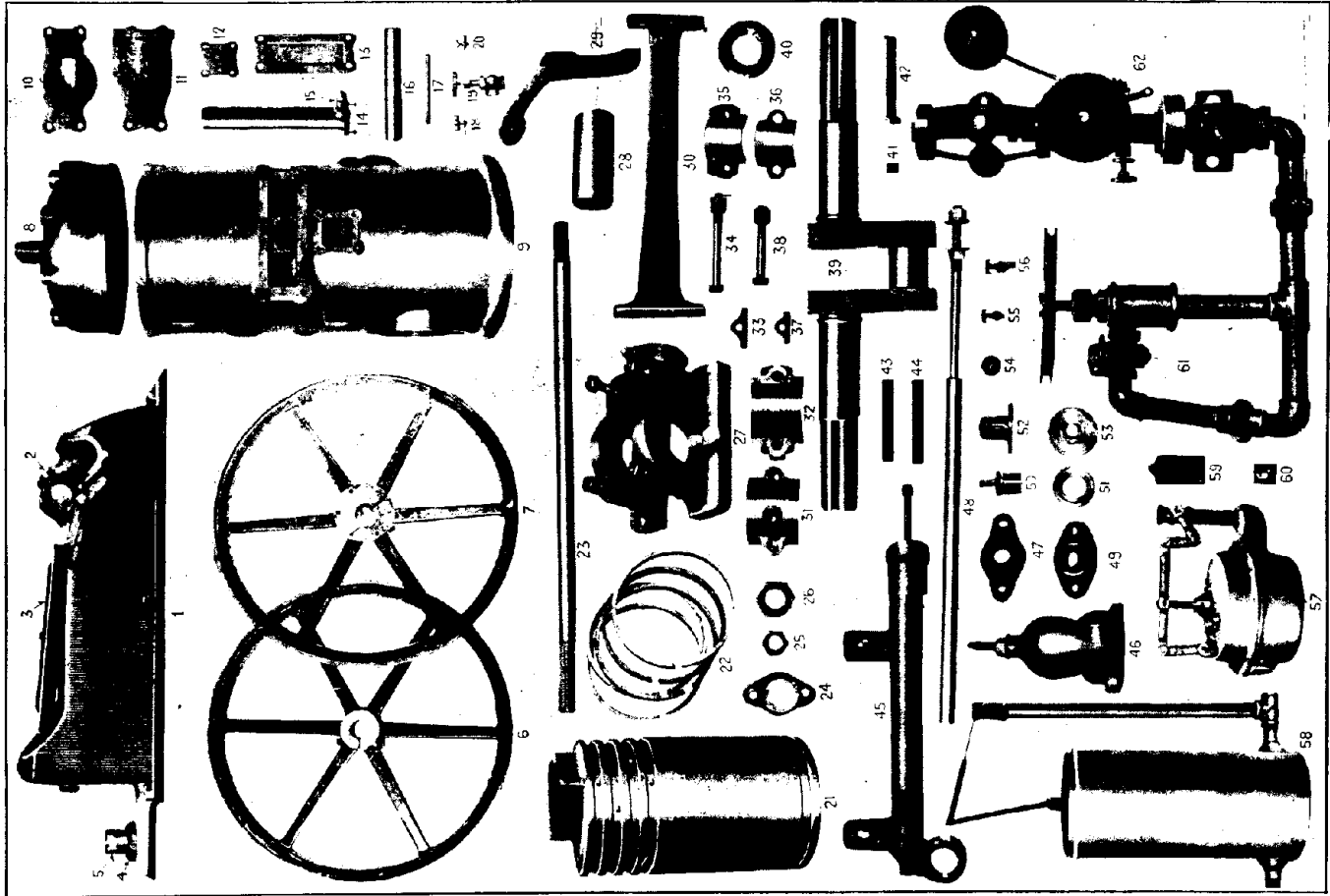
## PARTS FOR BALL GAS ENGINES

No.	Name of Part
1	Bed Frame Studded and Babbitted.
2	Main Bearing Cap Right Side Babbitted. Main Bearing Cap Left Side Babbitted.
3	Cross Head Guides (2 to a set).
4	Cylinder Support Nut.
5	Cylinder Support Screw.
6	Balance Wheel Straight Hub.
7	Balance Wheel Flanged Hub.
8	Cylinder Heads for Hot Tube.
9	Gas Cylinder Studded.
10	Straight Exhaust Nozzle.
11	Elbow Exhaust Nozzle.
12	Cleaning Hole Cover.
13	Port Cover.
14	Tube Furnace.
15	Tube Furnace Burner.
16	Tube Furnace Liner.
17	Nickle Hot Tube.
18	Furnace Gauge Cock.
19	Release Valve.
20	Drain Cock.
21	Piston Head.
22	Piston Rings.

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Parts for Ball Gas Engines and Clutches



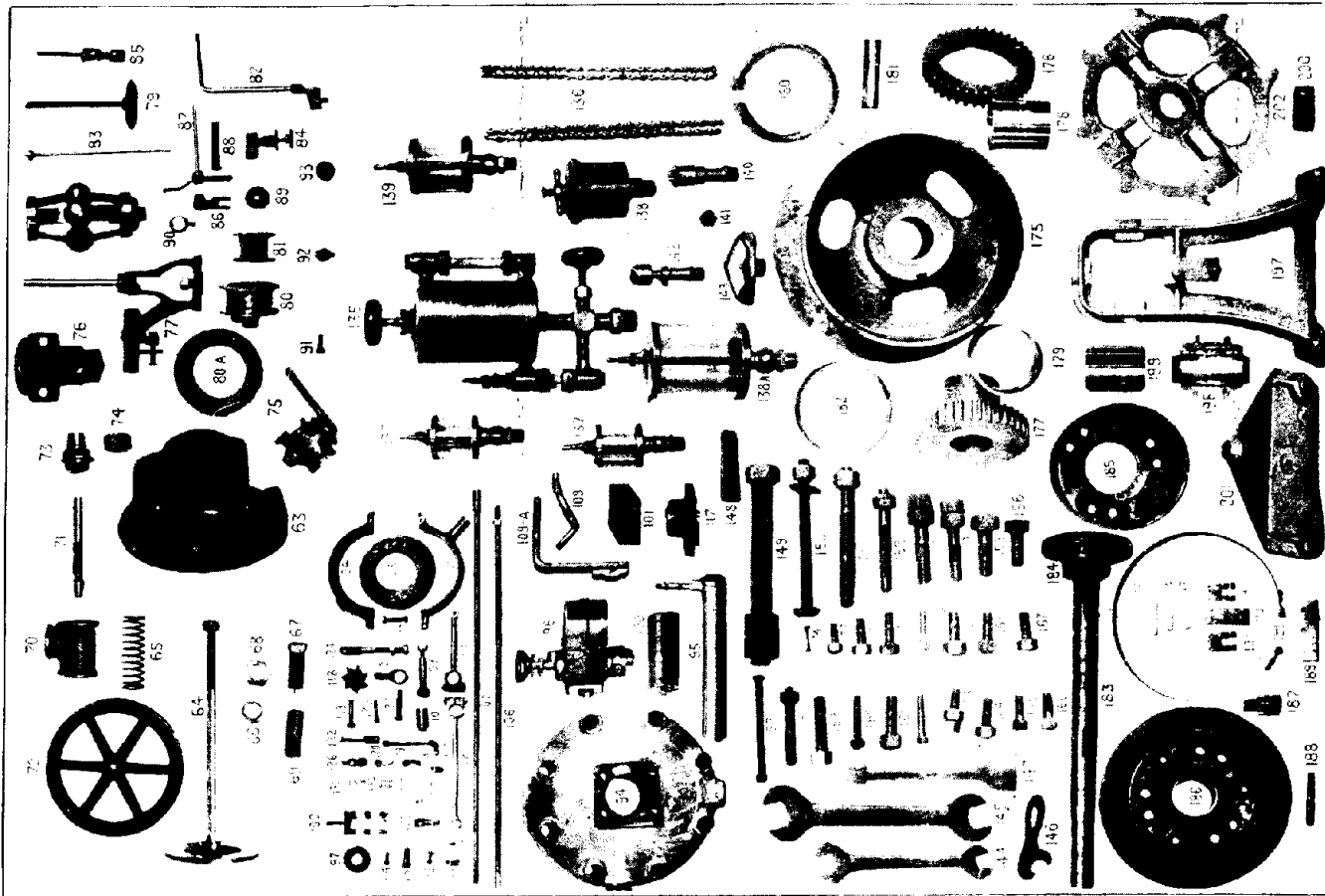
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No.	Name of Part	No.	Name of Part
23	Piston Rod.	45	Water Pump Barrel.
24	Piston Gland.	46	Water Pump Chamber.
25	Piston Head Nut.	47	Water Pump Bottom.
26	Piston Rod Nut at Cross Head	48	Flexible Pump Rod.
27	Cross Head.	49	Pump Rod Gland.
28	Cross Head Pins.	50	Brass Pump Valve (2 to a set).
29	Cross Head Pump Arm.	51	Brass Pump Valve Seat (2 to a set).
30	Connecting Rod.	52	Brass Pump Valve Cage (2 to a set).
31	Bronze Crank Box Front Half.	53	Brass Pump Valve Cage Seat (2 to a set).
32	Bronze Crank Box Pressure Half.	54	Brass Pump Valve Drop (2 to a set).
*32a	Brass Crank Box Lined with Babbitt.	55	Pump Air Cock. Release.
33	Crank Box Shims (2 to a set).	56	Pump Air Cock. Suction.
34	Crank Box Bolts (2 to a set).	57	Dry Gasometer.
35	Cross Head Box Pressure Half.	58	Fluid Gasometer.
36	Cross Head Box Back Half.	59	Oil Hole Cap (2 to a set).
37	Cross Head Box Shims (2 to a set).	60	Cross Head Guide Raisers (4 to a set).
38	Cross Head Box Bolts (2 to a set).	61	By-pass and Governor Complete.
39	Crank-shaft Long for Keyed Clutch.	62	Governor.
*39a	Crank-shaft Short, for Flanged Clutch.	63	Air and Gas Valve Chamber.
40	Governor Pulley	64	Valve Disk and Stem.
41	Governor Pulley Key.	65	Valve Spring.
42	Plain Hub Wheel Key.	66	Valve Spring Collar Nut.
43	Flange Hub Wheel Key.	67	Valve Travel Control.
44	Clutch Hub Key.	68	Valve Travel Control Nut.

\*Not illustrated.

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Parts for Ball Gas Engines and Clutches



The Ball

No.	Name of Part	No.	Name of Part
69	Valve Travel Stop.	93	Top Cap on No. 78.
70	By-pass Valve Body.	94	Cylinder Head.
71	By-pass Valve Stem.		M. & B. Ignition.
72	By-pass Valve Stem Cord Wheel.	95	Hot Tube Furnace.
73	By-pass Valve Neck.	96	Magneto Belt or Friction Drive.
74	By-pass Valve Neck Gland.	97	Magneto Leather Friction.
75	Gas Dial Gauge.	98	Magneto Brush and Spring.
76	Governor Chamber.	99	Magneto Brush Holder.
77	Governor Bracket Complete.	100	Dry Cells (6 to a set).
78	Fly Ball and Springs.	101	Resistance Coil.
79	Large Gear and Shaft.	102	Switch.
80	Belt Pulley.	103	Eccentric Hub and Belt Pulley.
80a	Belt.	104	Rear Eccentric Strap.
81	Idler Pulley.	105	Front Eccentric Strap.
82	Idler Pulley Shaft.	106	Eccentric Push Rod.
83	Top Rod.	107	Bell Crank Push Rod
84	Speed Control.	108	Bell Crank Stud.
85	Valve and Stem.	109	Bell Crank Bracket.
86	Toe Part.	109a	Eccentric Rod Bracket.
87	Trip Lever and Shaft.	110	Bell Crank Stud Sleeve.
88	Trip Lever Spring.	111	Bell Crank Short Section.
89	Trip Lever Ratchet.	112	Bell Crank Long Section.
90	Spindle Collar on No. 77.	113	Bell Crank Pins (2 to a set).
91	Bracket Screws.	114	Bell Crank Studs (2 to a set).
92	Oil Cup.	115	Bracket Screws (4 to a set).

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No.	Name of Part	No.	Name of Part
116	Eccentric Strap Bolts (2 to a set).	139	Cross Head Pin Oil Cup.
117	Sparker Body.	140	Cross Head Adjustable Wiper.
118	Star Wheel.	141	Cross Head Wiper Tip.
119	Star Wheel Stud.	142	Crank Adjustable Wiper.
120	Star Wheel Pawl.	143	Crank Wick Wiper Cup.
121	Star Wheel Link.	144	$\frac{1}{2}$ & $\frac{5}{8}$ Wrench.
122	Pawl Spring.	*144a	$\frac{5}{8}$ & $\frac{3}{4}$ Wrench.
123	Link Bolt.	145	$\frac{3}{4}$ & $\frac{7}{8}$ Wrench.
124	Reach Lever.	*145a	$\frac{7}{8}$ & 1 Wrench.
125	Reach Lever Swivel.	146	Governor Wrench.
126	Movable Electrode Hammer.	147	Socket Wrench.
127	Hammer Bolt.	148	Balance Wheel Hub Expander.
128	Movable Electrode.	149	Balance Wheel Hub Bolts.
129	Movable Electrode Lever.	150	Valve Lift Gauge Bolt in No. 47.
130	Movable Electrode Spring.	151	Cylinder Head Studs.
131	Hammer Spring.	152	Cross Head Guide Studs (4 to a set).
132	Stationary Electrode.	153	Main Bearing Cap Studs (8 to a set).
133	Mica Insulation.	154	Cross Head Clamp Studs (2 to a set).
134	Terminal Connection.	155	Cylinder to Bed Studs.
135	Gas Cylinder Oil Cups.	156	Water Pump to Cylinder Studs (2 to a set).
136	Main Bearing Oil Chains (2 to a set).	157	Water Pump Clamping Bolts (2 to a set).
137	Cross Head Slide Oil Cups (2 to a set).	158	Piston Rod Gland Studs (2 to a set).
138	Crank Pin Grease Cup.	159	Pump Rod Gland Studs (2 to a set).
138a	Crank Pin Glass Oil Cup.		*Not illustrated.

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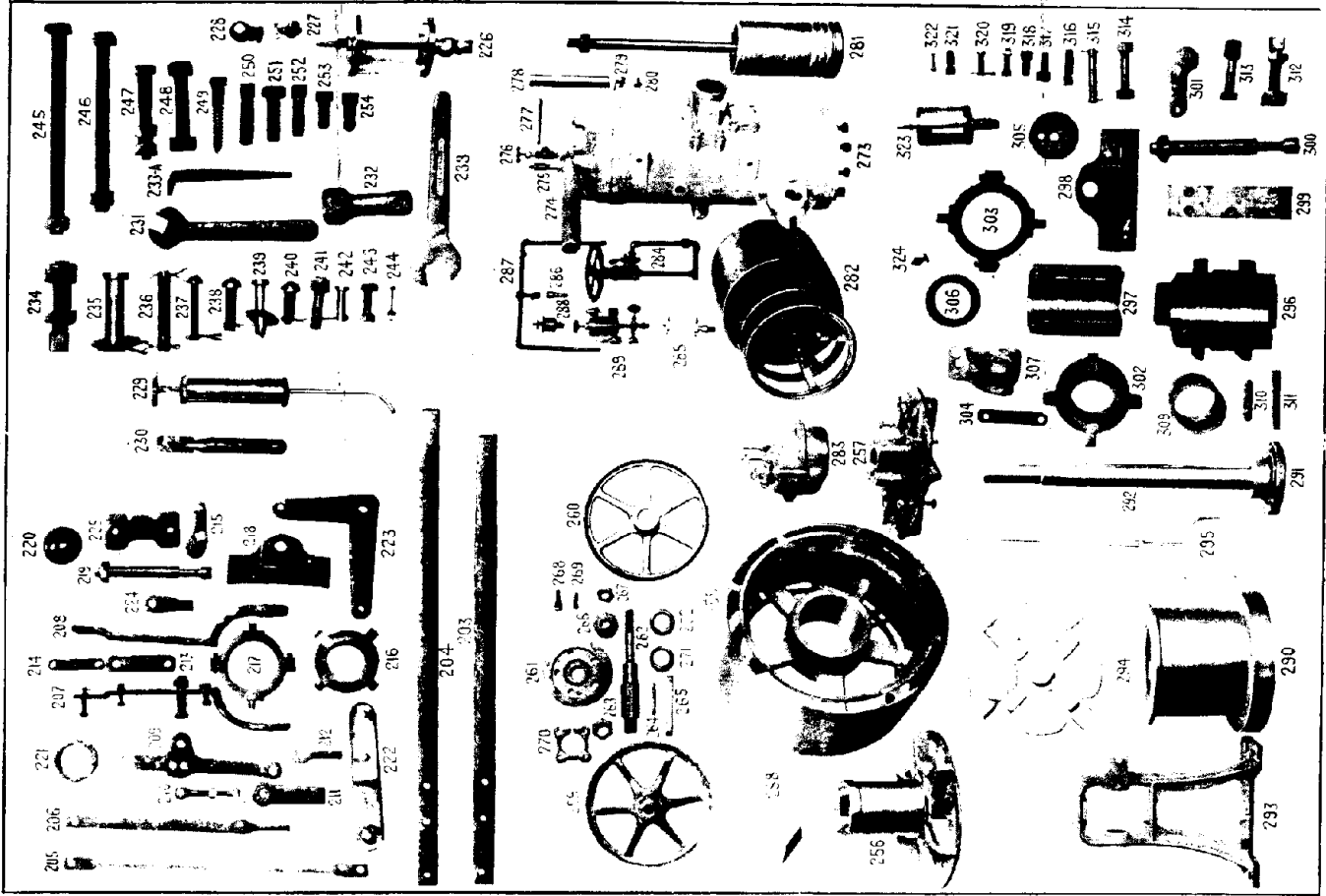
No.	Name of Part
160	Eccentric Rod Bracket Cap Studs (2 to a set).
161	Pump Arm to Cross Head Studs (2 to a set).
162	Bell Crank Clamping Studs (2 to a set).
163	Piston Rod in Cross Head Set Screw.
164	Governor to Bed Frame Studs (2 to a set).
165	Bell Crank Bracket Screws (2 to a set).
166	Eccentric Rod Bracket Screws (2 to a set).
167	Valve to Cylinder Studs (5 to a set).
168	Exhaust Nozzle to Cylinder Studs (4 to a set).
169	Sparker to Cylinder Head Studs (4 to a set).
170	Furnace to Top of Cylinder Head Screws (2 to a set).
171	Key Puller Stud.
172	Port Cover to Cylinder Studs (4 to a set).
173	Cleaning Hole Cover to Cylinder Studs (4 to a set).
174	Furnace to Cylinder Head Bolts (2 to a set).

**REVERSIBLE CLUTCH**

175	Belt Pulley.
176	Rim Gear on Belt Pulley Hub.
177	Reverse Gear.
178	Bronze Bushing for No. 175 (2 to a set).
179	Bronze Bushing for No. 186.

No.	Name of Part
180	Space Collar on No. 175.
181	Bronze Bushing for No. 187 (6 to a set).
182	Bronze Bushing for No. 185.
183	Main Shaft.
184	½ Flange Coupling on No. 183.
185	Pinion Gear Case.
186	Back Brake Wheel.
187	Pinion Gear (6 to a set).
188	Pinion Gear Shaft (6 to a set).
189	Wood Shoes for No. 218 (4 to a set).
190	Wood Shoes for No. 191 (9 to a set).
191	Back Brake Band.
192	End Clips for No. 191 (2 to a set).
193	Key for No. 175 and No. 176.
194	Key for No. 183 and No. 202.
195	Key for 183 and 184.
196	Key for 183 and 177.
197	Outer Bearing Stand.
198	Lower ½ Stand Box.
199	Upper ½ Stand Box.
200	Yoke Lever Bracket.
201	Lever Angle Plate.
202	Spider or Driver.
203	Hand Lever at Engine.
204	Hand Lever in Derrick.

Parts for Ball Gas Engines and Clutches



The Ball

No.	Name of Part	No.	Name of Part
205	Strap Connecting Nos. 222 and 223.	230	Grease Gun Paddle.
206	Strap Connecting 223 and 207-208.	231	Set Screw Wrench.
207	$\frac{1}{4}$ Part Yoke Lever.	232	Socket Wrench.
208	$\frac{1}{2}$ Part Yoke Lever.	233	Nut Wrench.
209	Swinging Lever for Back Break Band.	233a	Plug Wrench.
210	Adjusting Eye Bolt Joins No. 211 and 191.	234	Adjusting Screw for Nos. 198 and 199 ( 4 to a set).
211	Brake Band Clevis Joins No. 209 and 210.	235	Lever Studs for Nos. 222 and 223 (2 to a set).
212	Connecting Link between Nos. 213 and 222.	236	Pin Connecting Nos. 215 to 202 (4 to a set).
213	Strap Between Nos. 212 and 209 (2 to a set).	237	Pin for No. 192 (2 to a set).
214	Strap Between Nos. 216 and 215 (8 to a set).	238	Connecting Pins (11 to a set).
215	Adjustable Screw Dog (4 to a set).	239	Stud Joining Nos. 209 to 201.
216	Shifter Slide.	240	Pin for 203 and 204 to 225 (2 to a set).
217	Shifter, Yoke	241	Studs Connecting 197 to 200 (2 to a set).
218	Clutch Shoe (4 to a set).	242	Pin for Strap No. 214 (8 to a set).
219	Adjustable Screw for No. 218 (4 to a set).	243	Bolts for 207 and 208 (2 to a set).
220	End Thrust Plate for No. 183.	244	Bolts for No. 189 and No. 190 (38 to a set).
221	Thrust Collar for No. 183.	245	Foundation Bolts for No. 197 (4 to a set).
222	Connecting Lever for Nos. 209 and 223.	246	Foundation Bolts for No. 201 (3 to a set).
223	Bell Crank.	247	Bolt Joining Nos. 207 and 208 to 200.
224	Pipe Clips (4 to a set).	248	Flange Studs for No. 184 (6 to a set).
225	Floor Plates for 203 and 204 (2 to a set).	249	Lag Screws for Nos. 201 and 225 (6 to a set).
226	Glass Oil Cup for Nos. 198 and 199.	250	Set Screws for 184 to 195.
227	Drain Cock for No. 198.	251	Tap Bolt Connecting 185 to 186 (3 to a set).
228	Oil Cup for No. 186.	252	Set Screw Connecting 183 to 202.
229	Grease Gun for Gear Case No. 185.	253	Set Screw Connecting 202 to 194.



No.	Name of Part
254	Tap Bolt Connecting Nos. 220 and 183.
<b>ONE-WAY HAND-WHEEL CLUTCH</b>	
255	Belt Pulley
256	Hub and Wood Block Carrier.
257	Front Cover and Block Carrier.
258	Wood Blocks for Nos. 256 and 257
259	Outer-hand Wheel.
260	Inner-hand Wheel.
261	Hub Flange.
262	Flange Stem.
263	Nut Locking Nos. 261 and 262.
264	Key in No. 262.
265	Key Attaching No. 256 to Engine Shaft.
266	Pressure Nut.
267	Lock Nut.
268	Studs Attaching No. 261 to No. 256 (5 to a set).
269	Screws Attaching No. 270 to No. 257 (4 to a set).
270	Release Ring.
271	Upper Thrust Bearing.
272	Lower Thrust Bearing.
*272a	Roller Bearings.
*Not	illustrated.

### ONE-WAY LEVER CLUTCH WITH OUTSIDE BEARING

No.	Name of Part
290	Belt Pulley.
291	Flange Coupling.
292	Shaft.
293	Outer Bearing Stand.
*293a	Solid Pillow Block.
294	Spider or Driver.
295	Shifter Lever.
296	Lower $\frac{1}{2}$ Stand Box.
297	Upper $\frac{1}{2}$ Stand Box.
298	Clutch Shoe (4 to a set).
299	Wood Shoe for No. 298 (4 to a set).
300	Adjusting Screw (4 to a set).
301	Adjusting Screw Dog (4 to a set).
302	Shifter Slide.
303	Shifter Yoke.
304	Strap Between No. 301 and No. 302 (8 to a set).
305	End Thrust Plate for No. 292.
306	Thrust Collar for No. 292.
307	Shifter Lever Bracket.
309	Bronze Bushing for No. 290 (2 to a set).
310	Key for No. 294.
311	Key for No. 291 and No. 292.

No.	Name of Part
312	Adjusting Screw for No. 296 & No. 297 (4 to a set).
313	Bolt Joining No. 295 and No. 307.
314	Flange Studs for No. 291 (6 to a set).
315	Pins Joining Nos. 301 to 294 (4 to a set).
316	Set Screw for No. 294 to No. 292.
317	Studs Joining Nos. 307 and 293 (2 to a set).
318	Cap Screw Joining No. 305 and No. 292.
319	Bolt for No. 295 (2 to a set).
320	Pin for 304 (8 to a set).
321	Set Screw Nos. 294 on 310.
322	Bolt Joining 298 and 299 (20 to a set).
323	Oil Cup for No. 297 and No. 296.
324	Drain Cock for No. 296.

#### OPERATION OF CLUTCH AWAY FROM STAND

- \*325 Yoke Lever Complete.
- \*326 Bell Crank.
- \*327 Bell Crank Plate Complete.
- \*328 Pipe Connection for No. 326.
- \*329 Strap Connecting No. 325 to No. 326.
- \*330 Hand Lever.
- \*331 Pipe Connection for No. 330.
- \*332 Floor Plate for No. 330.
- \*Not illustrated.

## Rules for Calculating the Speed and Diameter of Clutches, Pulleys and Band Wheels

### PROBLEM NO. 1

To determine diameter of clutch needed, when diameter of driven wheel and revolutions are known.

RULE: Multiply the diameter of driven wheel in inches by its revolutions per minute and divide this product by number of revolutions desired to run engine the quotient of which will be the diameter of clutch in inches.

### PROBLEM NO. 2

To determine engine speed when driven wheel diameter and revolutions with clutch diameter are known.

RULE: Multiply the driven wheel diameter in inches by its revolutions per minute and divide the product by the clutch diameter in inches the resultant quotient will be the engine speed.

### PROBLEM NO. 3

To determine diameter of driven wheel when its revolutions per minute, engine revolutions and diameter of clutch are known.

**RULE:** Multiply the clutch diameter in inches by the engine revolutions per minute and divide the product by the number of driven wheel revolutions per minute, the quotient of which will be the diameter in inches of driven wheel.

#### PROBLEM NO. 4

To determine speed of driven wheel when its revolutions, engine revolutions and diameter of clutch are known.

**RULE:** Multiply the clutch diameter in inches by the engine revolutions per minute and divide the product by the diameter in inches of the driven wheel, the quotient of which will equal the revolutions of the driven wheel.

In installing **main line shafts, counter and jack shafts** where the gas engine is the motive power, the foregoing rules will enable the operator to start from the engine speed and establish all shaft speeds, diameter of pulleys through the line and counter shafts to the pulleys on machines to be operated.

Main line shafts are run at about 200 revolutions for ordinary purposes. In instances where high speed machinery is being set up the line shaft can be driven faster in order to avoid unduly large drive and small driven pulleys.

These same rules can be applied to gearing by substituting for the pulley diameters the number of teeth in the gears.

#### RULES FOR BOARD MEASURE

Multiply the length in feet by the width and thickness in inches, and divide the product by 12, which quotient will equal the board feet. Thus a scantling 26 feet long, 2 inches thick and 6 inches wide contains

$\frac{26 \times 2 \times 6}{12} = 26$  feet, board measure.

12

#### CONCRETE FOUNDATIONS

Concrete foundations for engines and machines in which there is shock and vibration should be made from mixture of one (1) part cement, two (2) parts sand and four (4) to five (5) parts broken stone, gravel or mill slag of one (1) inch size. The sand should be either lake, river or ground which will not contain loam.

Road sand, as sometimes used, is not fit for strong concrete work, as such sand contains much loam. Mill slag of one (1) inch makes the very best material procurable for the body of mixture. If large pieces of stone are dropped in keep them away from form and well

spaced so mixture will run around them, a portion of gravel should be left out of the mixture.

If the foundation can not be completed in a working period leave the last pour rough on top so next period's mixture will have better hold. If it dries out during the intermission scatter pure dry cement over the top before pouring the regular mixture, which will tie them together in a homogenous mass.

To give a smooth finish with little pointing to be done push the shovel down along the side of form forcing back the coarser parts which will let the thinner portions against the form.

In mixing on board turn it over three times while in dry state and two times after addition of water. Do not use more water than will thoroughly wet the mass

as it is apt to leak out cracks in form carrying pure cement in solution.

The foundation should be finished within one (1) inch of the required height with rough top and allowed to set enough to hold the engine or machine. Level up machine to required bolt length with narrow strips of iron after which pour a thin solution of one (1) part cement and two (2) parts sand into form slipped over top of unfinished foundation. This form should be high enough that the thin mixture will run under and around bottom of machine and up to the top edge of machine bottom flange. When this grouting is set tighten down the foundation bolt nuts securely which will make a very rigid set up for any kind of machine.



*The Ball*